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VOLUME 7 ■ NUMBER 1 ■ SUMMER 1997

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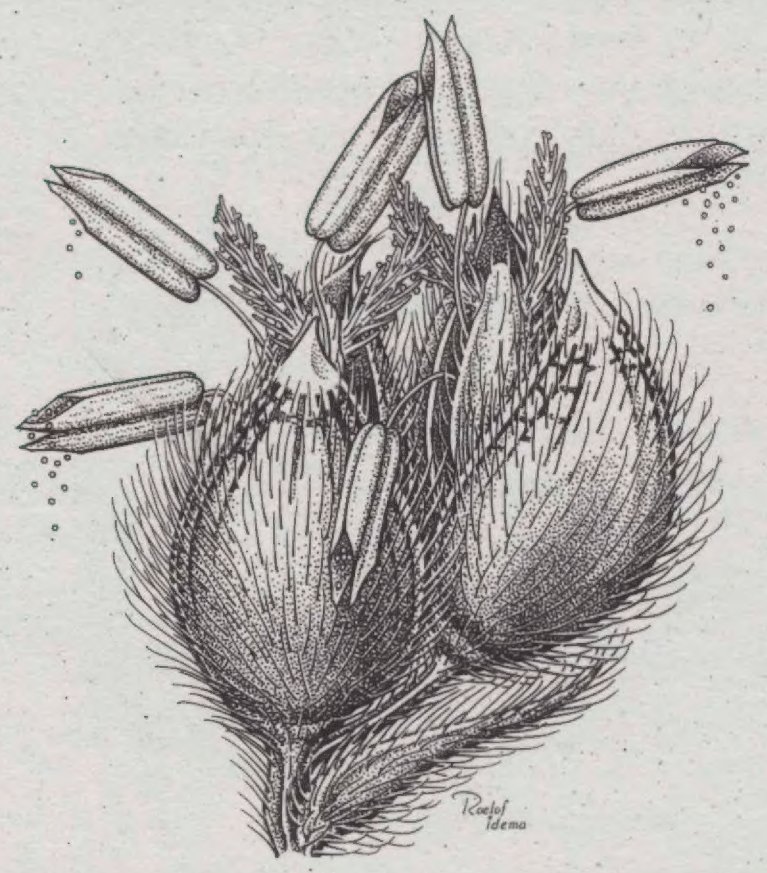
Global biodiversity

An International Forum on the Variety of Life on Earth...
research, conservation and wise use



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Privatization of crop seeds

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Alien species

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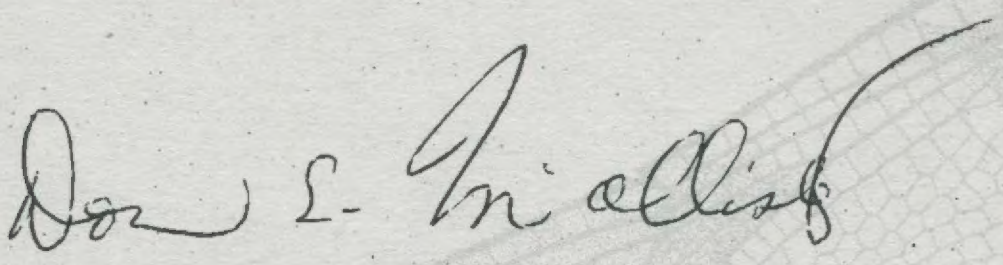
CLONING AND ENGINEERING SHEEP AND OTHER BEINGS

The cloning of a sheep by a UK team led by Dr. Ian Wilmut in Edinburgh, as reported in the media in late February, has caused a furor. The team inserted the nuclear DNA from one sheep's body cell into the denucleated egg of another sheep. The fused egg began dividing into cells and was implanted into another ewe, which later gave birth to the cloned lamb. The new process shortens an earlier procedure whereby ovulated eggs were collected from, for example, a valuable milch cow, fertilized *in vitro*, and implanted in a second less-valuable cow to produce a calf genetically similar to but not identical to the egg-mother. The new procedure eliminates tricky egg collection techniques, is not limited by the number of ovulated eggs available, and skips the stage requiring fertilization with sperm.

The biological implications are two-fold. First, cloning produces twice as much genetic uniformity as previous procedures. Both pairs of chromosomes in the progeny will be identical to the maternal ones. From the point of view of industrial genetics of plants or animals, this is "good" — it assures production of a high level of milk, cornstarch, or other desired products. The downside is that nature abhors genetic uniformity (as well as vacuums!). Diseases, pests, and predators will adapt quickly to the genetically uniform host. So cloning goes against natural evolutionary and ecological principles, exposing the descendants to long-term risks, whatever the short-term benefits.

Second, cloning produces another tool in the arsenal of animal genetic engineering. Once the tricky insertion of an alien gene is made into a nuclear chromosome, then cloning provides the power to "photocopy" many duplicate progeny. In an article on the "alcorobe" in *Global biodiversity* 2(4): 32, we noted that genetic engineering has significant potential advantages and risks. The risk is not always apparent without deep thoughtful consideration, a commodity rare in the brisk world of globalized promotion and marketing.

Not yet do we have the artificial womb predicted in Aldous Huxley's novel, *Brave New World*. But we would do well to ponder the consequences of what we do with what we know right now in 1997.



Don E. McAllister
Editor

Please join the debate

I encourage readers, with access to the Internet, to join the *Global biodiversity* Forum now posted on the Canadian Museum of Nature web site <http://www.nature.ca/english/gbfor.htm>. Topics will change quarterly; "The Fair Sharing of Benefits" is now under discussion. Watch for forestry topics to be posted later in the summer. [D.E.M.].

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- *Publish articles, views, and news on biodiversity*
- *Bridge the gaps between professional disciplines & the public*
- *Communicate vital information to help humankind make decisions on the fate of the Earth's life*
- *Express views on the needs & value of biodiversity research*
- *Provide an international forum for discussing issues on biodiversity*
- *Enhance awareness of the role of biosystematic research & museum collections to conservation & ecologically sustainable use of biodiversity*
- *Discuss methods and philosophy of biodiversity conservation*
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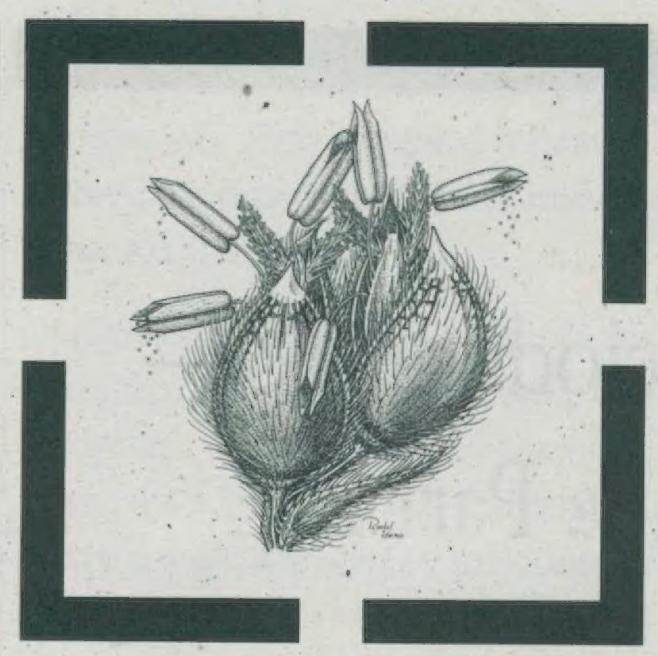

Part of a sorghum seed head. Who should take the responsibility for the genetic biodiversity of crop seeds? For more information, see page 9.

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Global biodiversity is published quarterly. Annual subscription rates: In Canada $26.75 for individuals, $53.50 for institutions (includes GST). Quebec residents please add 6.5% QST. Outside Canada, US $26.75 for individuals, US $53.50 for institutions. A reduced rate of US $15.00 is available to subscribers in developing countries. Claims for missed issues will be honoured up to six months after the missed issue within Canada, and up to one year outside Canada.

Version française disponible:
La biodiversité mondiale
ISSN 1195-3101 (English edition)
ISSN 1195-311X (édition française)

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Biodiversity, ecodiversity, sociodiversity — Three aspects of diversity: Part 2

Pierre Dansereau

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ECODIVERSITY: ECOLOGICAL OPPORTUNITY

In an essay on "the varieties of evolutionary opportunity" (1952), I attempted to fit genetic systems into an ecological framework and gave numerous examples (see also Dansereau 1957). As discussed in Part 1 of this series, published in *Global biodiversity* 6(4), the exchange or function that takes place between an organism and its environment depends upon its genetic stock and upon the adjustment of its capacities. In Part 2, I will show in greater depth how this adjustment will determine a species' ecological valence or opportunity or, in other words, its ecodiversity. Having done this, the discussion will then turn to exploring a species' part or role in social sharing (sociodiversity) in Part 3, to be published in *Global biodiversity* 7(2).

The various functions that a species assumes can appear on four levels: in the genotype, the phenotype, the coenotype, and, in the long run, the geobiotype. Each one of these levels of adaptation lends itself to a more or less complex classification. As far as plants are concerned, for instance, the following types of functional categories can be recognized (See Figure 5):

On the primary instance of the *genotype*, which is defined at the level of molecules and chromosomes, plant reproductive functions can be either sexual, vegetative, or apomictic (reproduction without fertilization).

On the next level up, we find the *phenotype*, which is the expression of the internal mechanics of the genotype whereby cells, tissues, and organs respond to the environment in a resolution that gives shape and

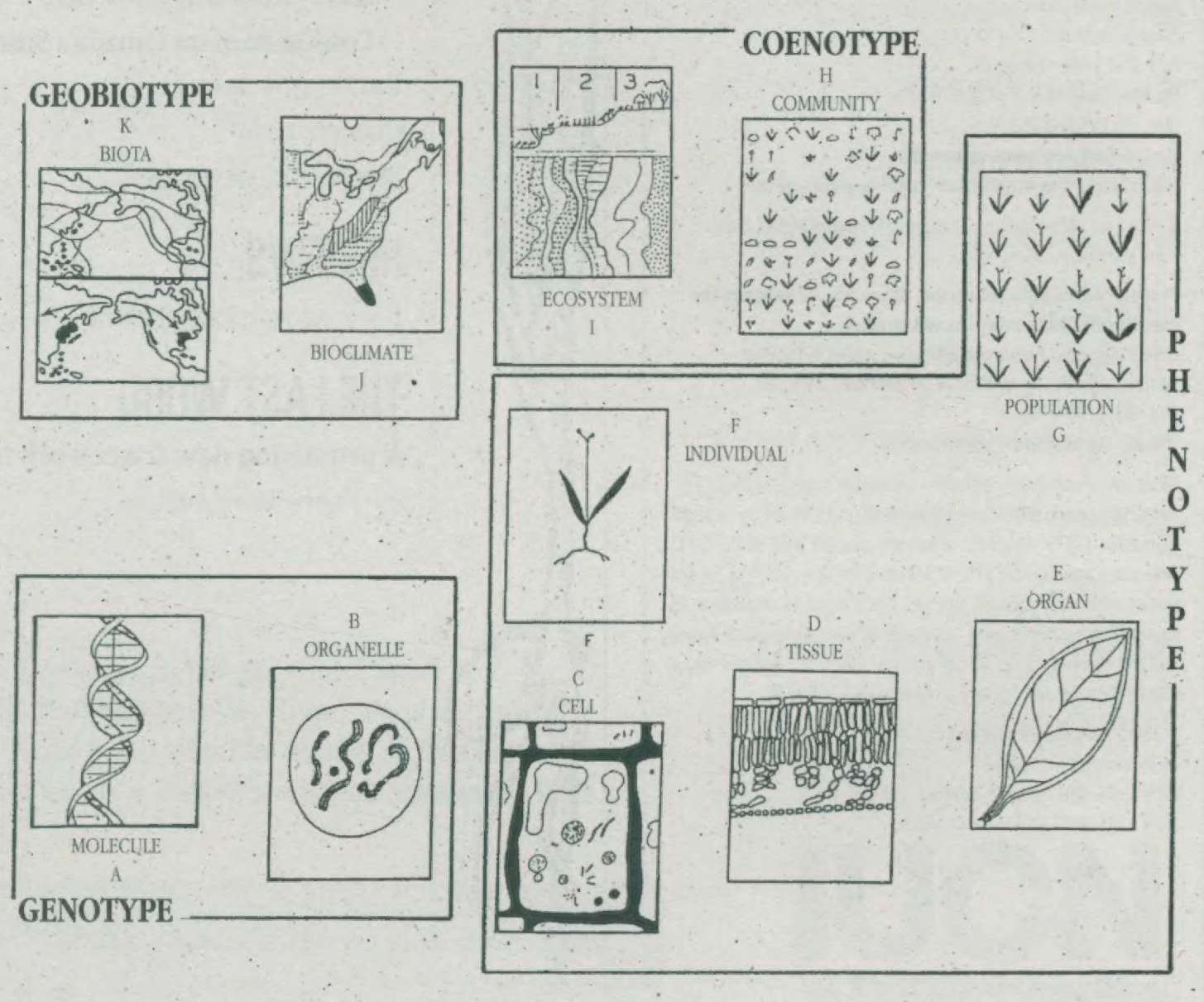

Figure 5. FOUR FUNCTIONAL ASPECTS OF SPECIES during their ontogenesis

function to the individual. Thus, a population of a certain species will display a limited number of phenotypes. In plants, we discover uniform or labile traits, those easily changed and modified.

Progressing to the next level, things become more complex. The *coenotype* is the mode of adaptation of the organism to one or more environments, in which it assumes a particular function within the community (where it is constrained by the sharing of resources) and in the ecosystem (where it is submitted to a particular cycling rhythm). Thus, in plants we find a variety of life forms (phanerophytes, epiphytes, chamaephytes, hemicryptophytes, geophytes, therophytes) accompanied by a diversity in methods of dispersal (anemochore, zoochore, etc.). Phenology varies (evergreen, semi-deciduous, deciduous, leafless) as does a plant's adaptations to length of day. Variety in the coenotype can also be reflected in a plant's *ecology* (hygrophilous, mesophilous, xerophilous) and finally, in its *sociology* (dominant, sub-dominant, subordinate, occasional; rare; solitary, gregarious; sedentary, migratory).

At the fourth and broadest level, the *geobiotype* is determined by the phylogeny as affected by the vicissitudes of geological changes (continental drift, heavings in orographic or relief factors, glaciations, desertification, etc.). Each geobiotype is more or less linked to a formation class (tropical rainforest, temperate steppe, arctic tundra, etc.). So, hearkening back to plants once again, we find those that are cosmopolitan/endemic; those with continuous/discontinuous distribution; those found on continental/regional/local levels; those categorized according to historico-geographic features: boreal, sahelian, patagonian, etc.

The repertory of genetic adaptations within these four major categories is endless. Let us cite a few examples:

- aquatic plants with spongy cells; succulent plants almost without stomata (breathing cells) and with finely and widely diffused roots; annuals capable of accomplishing a full cycle in a few weeks; trees with buttresses or emergent respiratory roots; epiphytes and parasites;
- hibernating or estivating animals; migrating insects, birds, mammals; flying fish and mammals; mimetic insects; ruminant, gnawing, carnivorous mammals;
- some tropical peoples with dark skins, mountain peoples with strong lungs, women who have more fatty tissue deposits than men for child-bearing reasons.

These few examples evoke an exceptional capacity in the individual to meet the challenges of its environment where the excess or deficiency of a given resource requires a variety of responses to a particular stress. It is then necessary to focus upon the site so as to encompass its *harbouring capacity*, which is a balance between the resources it offers and the stresses it imposes.

In order to assess properly the performance of a plant, an animal, or a human, one must run the range of its *adjustment*, which is its requirement/tolerance/capacity ratio. Table 1 attempts to place within the environmental matrix the criteria that allow a perception of *ecological strategy*. It is in the autecological view that the three elements of biological response will appear (read Figure 3, published in Part 1, p. 6 in 6(4), downwards):

- **Requirement** is the ineluctable need of the organism for a given resource (air, water, food, reproduction, dispersal) at each phase of its life cycle (germination, growth, flowering; fruiting; birth, adolescence, reproduction, work). Thus, cyperus *(Cyperus papyrus)* requires a lot of water, prickly pear *(Opuntia ficus-indica)* thrives with a small amount; horse and camel are much in the same relation; the European needs more heat than the Inuit. It must be noted that, beyond the basic elements that supply major metabolic currents, there are those that are indispensable to a particular function, if only in minimal amounts.
- **Tolerance** is the response to stress undergone through excess or deficiency of a given resource. The hardiness of many cultivated plants is abundantly known and taken advantage of by humans: many species "withstand" the Canadian winter or the tropical summer; many animals are likewise "acclimatized"; the explorers have exhibited their "endurance" in the desert, in the polar world, and in the mountains.

It is readily seen how an organism is assured of its survival in one or more environments inasmuch as its requirements are satisfied minimally and its maximal tolerances are not overcome. Following the lead of Merriam's (1898) "life zones", agriculturists and horticulturists have adopted "hardiness zones" that appear in all of the manuals (Wyman 1971, Royal Horticultural Society 1992).

But these two parameters do not define an organism's capacity to play a more or less important role within the ecosystem(s) that fulfill its requirements and do not exceed its tolerances.

- **Capacity** is the aptitude shown by an organism in its exploitation of one or more resources. Two species occupying the same site, and displaying the same requirements and tolerances, will tap the available resources unevenly. In a maple forest of the Montreal region, the sugar maple *(Acer saccharum)* will reproduce much more abundantly than the beech *(Fagus grandifolia)*, and in the course of a season, will use up a much greater amount of solar energy, heat, light, water, and soil nutrients. On a sea cliff in the Gulf of St. Lawrence, the gannets *(Morus bassanus)* occupy much more space than the cormorant *(Phalacrocorax auritus)*; in the construction of metal bridges, some Mohawks are gifted with or acquire greater agility and balance than most Europeans.

The test of RTC formula (requirement, tolerance, and capacity) consists in discovering the *valence* or opportunity of the organism in one or more environmental gradients. Table 1 gives some examples. So, for instance, the quaking aspen has a greater valence than the sugar maple; the red-winged blackbird, a greater valence than the whooping crane.

As far as the supply of one element in particular is concerned (water, for instance — i.e. *hygric*), an organism could be considered *steno-hygric* if it is encountered in nature in narrowly defined conditions of humidity or on the contrary, *eury-hygric* if encountered sometimes on a wetter, sometimes on a drier site. This is a matter of ecological amplitude or narrowness, of a more or less wide range.

Table 2 records, for Eastern North America, some examples of responses to light, humidity, and soil reaction. The right column (under "Range") lists species that occupy the minimum, the median, or the maximum of the given resource but whose amplitude is very narrow. The left column (under "Range") on the contrary, contains species capable of functioning at distant points of their optimum by tolerating an excess or deficiency of the resource. The central "Range" column of Table 2 draws attention to the *amphivalents*, that is, the species that exhibit a requirement for a seasonal increase or decrease of the resource in the course of their life-cycle. It is, therefore, the quantitative change in water or light in the ecosystem itself that will allow these *amphivalents* to fulfill their life-cycle. Thus, the wild leek *(Allium*

Table 1. ECOLOGICAL STRATEGIES OF SIX ORGANISMS in various Canadian environments.
H = high;
L = low;
V = variable.
(Dansereau 1991)

AREA	ORGANISM	REQUIREMENTS	TOLERANCE	CAPACITY
Eastern forest	sugar maple	H cold and humid climate; soil deep and well aerated; constant shade in summer	H very cold winters; early and late frosts; insect parasites	H abundant dissemination of seeds; good rate of growth; dominance
Grassland	quaking aspen	L open areas for establishment	H variety of soils; resistance to fire; insect parasites	H intensive vegetative propagation; rapid growth
Southern cattail marsh	red-winged blackbird	L marshes for nesting; varied landscape for feeding	H fluctuations of water level; changes in marsh dynamics	H territoriality; high reproductive rate; gregariousness
High northern marsh	whooping crane	L narrowly limited marsh area at each end of migration path	L competition with other birds	L vulnerability to habitat change; predators; low reproductive rate
Maritime arctic tundra	Inuit	H Extremely high fat and protein diet	H cold; scarcity of vegetable food	L survival requires considerable cultural skills and occasional innovation
Southern industrial town	factory worker	L minimal food and shelter	H substandard living conditions	V survival depends on a patterned, mostly imposed, technology

		RANGE		
Factor	**Intensity**	**Wide (eury-)**	**Fluctuating (amphi-)**	**Narrow (steno-)**
LIGHT	heliophilous HIGH	euryphotic: *Pteridium aquilinum* Bracken *Phleum pratense* Timothy	amphitolerant: *Hepatica acutiloba* Acute-leaved liverleaf *Allium tricoccum* Wild leek	stenophotic: *Solidago nemoralis* Woodland goldenrod *Rumex acetosella* Sheep-sorrel
	MEDIUM	*Tilia americana* Basswood *Prunus serotina* Black cherry	*Hystrix patula* Bottle-brush grass *Trillium erectum* Purple trillium	*Acer rubrum* Red maple *Cornus canadensis* Bunchberry
	sciophilous LOW	*Aster acuminatus* Acuminateus aster *Maianthemum canadense* Wild lily-of-the-valley	*Prenanthes alba* White lettuce *Solidago flexicaulis* Flexuous-stemmed goldenrod	*Corallorhiza maculata* Spotted coral-root *Phryma leptostachya* Lopseed
HUMIDITY	aquatic VERY HIGH	euryhygric: *Butomus umbellatus* Flowering rush *Sagittaria latifolia* Arrowhead	*Eleocharis acicularis* Needle-shaped spike-rush *Littorella americana* American littorella	stenohygric: *Ceratophyllum demersum* Hornwort *Naias flexilis* Flexible naiad
	hygric HIGH	*Lycopus americanus* Water-horehound *Calamagrostis canadensis* Bluejoint	*Laportea canadensis* Canadian wood-nettle *Impatiens capensis* Touch-me-not	*Lobelia cardinalis* Cardinal flower *Vaccinium oxycoccus* Small cranberry
	mesic MEDIUM	*Aster acuminatus* Acuminate aster *Maianthemum canadense* Wild lily-of-the-valley	*Bidens frondosa* Bur-marigold *Osmunda claytoniana* Interrupted fern	*Dicentra cucullaria* Dutchman's-breeches *Orchis spectabilis* Showy orchis
	xeric WEAK	*Ambrosia artemisiifolia* Ragweed *Pyrola elliptica* Shinleaf	*Vaccinium angustifolium* Low sweet blueberry *Betula populifolia* Gray birch	*Sedum acre* Mossy stonecrop *Gaylussacia baccata* Black huckleberry
REACTION	basophilous HIGH	euryionic: *Thuja occidentalis* White cedar *Potentilla fruticosa* Shrubby cinquefoil	n.a.	stenoionic: *Camptosorus rhizophyllus* Walking fern *Viola canadensis* Canada violet
	neutrophilous MEDIUM	*Calamagrostis canadensis* Bluejoint *Erythronium americanum* Yellow adder's tongue	n.a.	*Carex pedunculata* Peduncled sedge *Hydrophyllum virginianum* John's cabbage
	acidophilous LOW	*Drosera rotundifolia* Round-leaved sundew *Circaea alpina* Alpine nightshade	n.a.	*Sarracenia purpurea* Pitcher plant *Chamaedaphne calyculata* Leather-leaf

Table 2.
ECOLOGICAL VALENCE illustrated by eastern North American plant indicators that show narrow and wide adjustment to light, soil moisture, and pH.

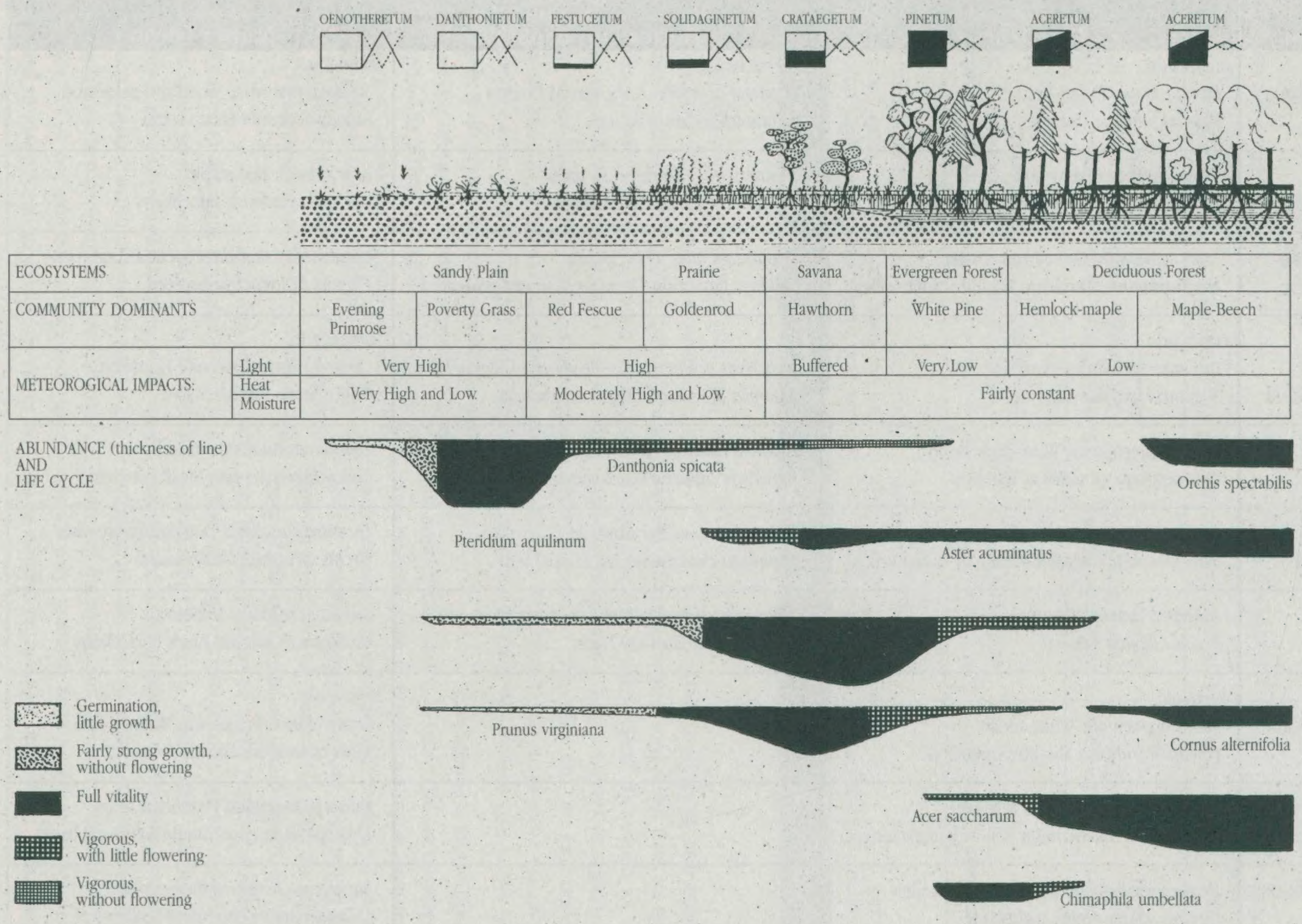

Figure 6.
A TRANSECT IN THE ST. LAWRENCE LOWLANDS showing eight plant communities (named for their dominant species) and ranging through five ecosystems. Light, heat, and moisture are gradually buffered in their impacts from left to right, from extreme variation (night/day and winter/summer). The abundance of selected species is proportionate to the thickness of the transect line, which also shows what stage of the life cycle is able to develop; full vitality is shown in black.

First, evergreeness is present in three herbaceous species besides the dominant fir; there are none under the maple, although the sedge and the hepatica do retain some leaves during the winter; and the ephemeral cycle in the maple forest, due to light intensity in the spring, does not appear in the balsam fir forest. Thus the rhythm, and therefore the ecosystematic regime are very different.

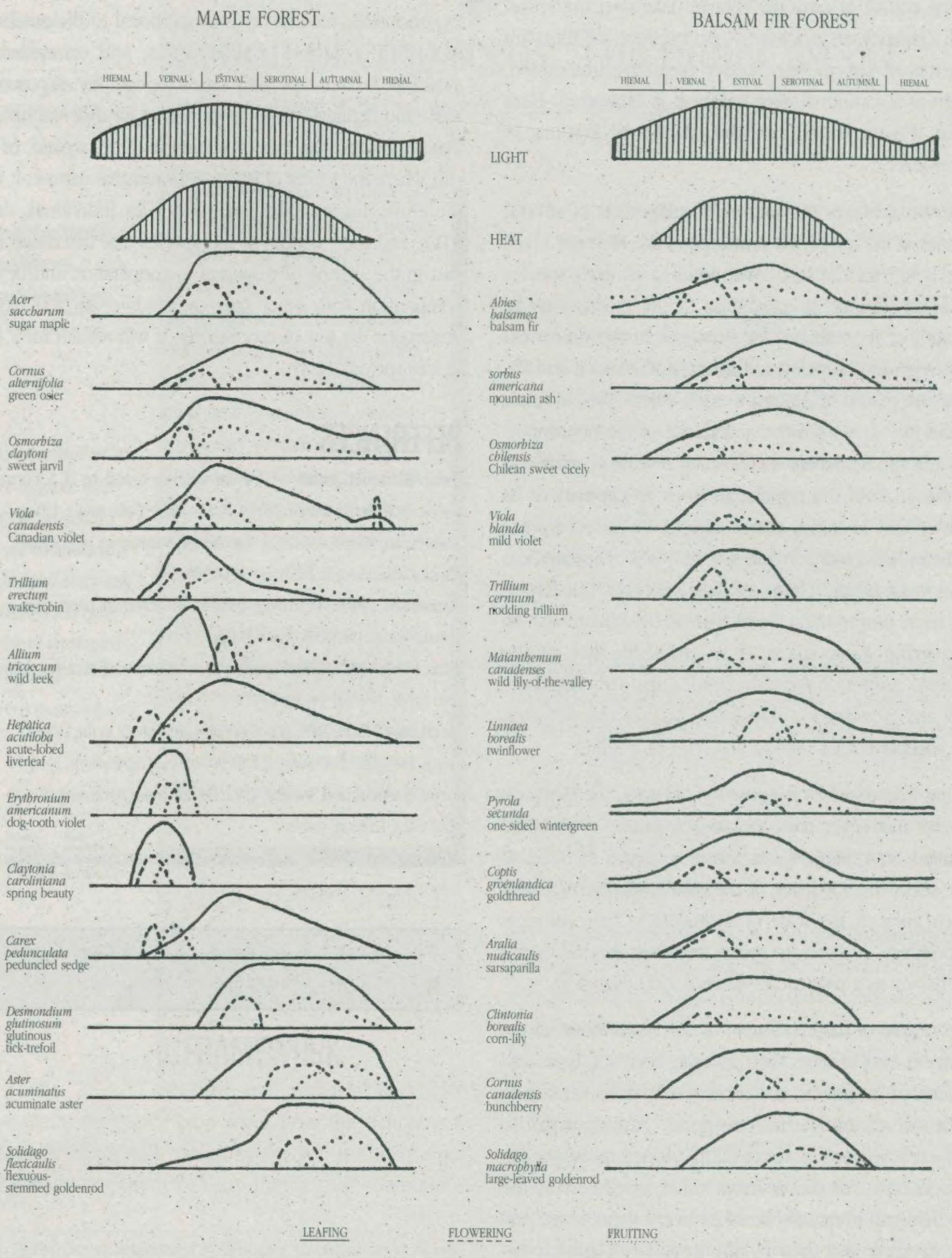

Figure 7. PHENOLOGY OF 13 TYPICAL SPECIES of the maple and balsam fir forests sowing the response of plants to seasonal change.

tricoccum) needs abundant light for its vegetative phase and an equivalent of fresh shade in order to flower and bear fruit. It will be the forest ecosystem (the maple forest) that will alter the supply of light to the wild leek in the course of seasonal change. Likewise, the spike-rush *(Heleocharis acicularis)* can produce its abundant rosettes of leaves only under complete immersion, whereas it cannot flower unless it is immersed. Here again, it is the habitat itself that changes by lowering its water level.

Figure 6 analyses the phases of adaptation of several species in the temperate landscape of the Montreal Plain. The length of the bar corresponding to each species gives an idea of its amplitude or the narrowness or breadth of its potential for existence in the ecosystem with regard to humidity and light (i.e. the steno- and the eury- are placed in contrast to each other). The thickness of the line shows relative abundance of the populations of each species where the thinning reveals in what part of the gradient the population loses its *capacity* or its *vitality* and becomes more vulnerable. An *ecological optimum* is achieved by the species where the plants can go through all the phases of their life-cycle ("vitality" in the sense proposed by Braun-Blanquet 1932) and also by occupying more space. It would seem that, at the extreme ranges of their amplitude, they can germinate well and grow but not flower and fruit, or else persist in the vegetative state without flowering or fruiting.

Figure 7 accounts for the seasonal behaviour of 13 typical species that cover the phenological gamut, or seasonal changes, in a maple forest and in a balsam fir forest. If one seeks the adequacy of the biological potential (at a given point in the scale of aptitudes) to the ecological opportunity, it therefore seems important to characterize the habitat as a *receptacle* (see Dice 1952, Figure 4).

The regime of the ecosystem, or the combination of the basic "control" factors such as light, heat, soil type, and water that govern its existence, is a basic dimension to which communities must respond. Turning again to Figure 6 we see a succession of communities (or associations) that can develop within an ecosystem: the old field will eventually be taken over by the prairie and the savanna and then by the needle-leaf pine forest which, in turn, will be succeeded by the deciduous forest. Landscape dynamics allow changes in regime, therefore the crossing of major thresholds.

In such a landscape, it is quite evident that the development of soil horizons and stratification of vegetation mean an increase of ecotopes and niches (see Figure 3) and, consequently, greater ecodiversity.

In conclusion, *ecodiversity* is proportional to the number of niches, ecotopes, communities, and ecosystems available. A landscape with varied topography, exposure, soils, and drainage offers *opportunities for differentiation* that are higher than that of a shore, a dune, a plain, or a cliff where the gamut of ecosystems remains narrow. It is, therefore, the genetic make-up of an individual, the RTCs, and the valences of the species that determine its part in the sharing of resources in cooperation and/or in competition with other species. Biodiversity will have undergone the test of ecodiversity; it will remain for it to fit into sociodiversity.

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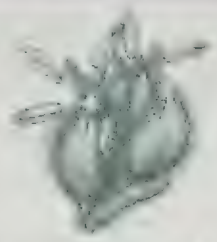
Watch for Part 3, on sociodiversity, in Fall 1997. Part 1, on biodiversity, was published in *Global biodiversity* 6(4): 2–9.



Privatization of crop seeds: The public aspect*

Claude André St-Pierre,[1] André Comeau,[2] and Benoît Gauthier[3]

In the first three or four billion years, evolution "discovered" that species populations that survived best were genetically variable, but adapted to their environment. In 10,000 years indigenous peoples and traditional small-scale farming societies learned that crop land-races produced well and dependably when genetically variable and adapted to local conditions. In tens of years industrial seed companies — using land-races and wild biodiversity — learned to select new varieties for high production (and input) with restricted genetic variation. In the same timespan, marketing successfully supplanted land-races with the new varieties and development took over land occupied by wild relatives. These recent activities are putting our genetic heritage at risk. It is time to call for government action for greater awareness, better seed banks and in situ *conservation (both in the public sector — provincial, federal, and international — as well as in the private sector), and greater awareness of* all *plant biodiversity, not just that of crops. [D.E.M.]*

And of every living thing, of all flesh, you shall bring two of every kind into the ark, to keep them alive with you; they shall be male and female.

God to Noah, Genesis 9:19

PHILOSOPHICAL FRAMEWORK

Throughout the centuries, individual farmers have gradually developed crop seeds from the rich genetic diversity of naturally occurring species. It is only since the early twentieth century that a true commercial production of crop seeds has replaced the hand labour of crop selection. In recent times, then, the *in situ* diversity of naturally occurring genetic resources has been dramatically rounded out by *ex situ* collections of crop seeds and transplants. Together, these two types of diversity form what is now appropriately called the "vegetal biodiversity." The traditionally direct relationship between individual farmers and nature thus finds itself in a much more complex relationship that is coloured by the needs of society as a whole, and increasingly, by industry. Historically, peasants of the world had full responsibility over the choices and preservation of seeds. Modern knowledge, politics, economies, and cultures have dramatically altered the role of farmers of the world.

Following the example of many authors, Deshaies (1992) presents a model that allows humans to study and act while taking into account the complex relationship between humanity, nature, and society. In terms of the conservation and industrialization of crop seeds, this triptych includes and broadens the traditional ecosystem approach, which is based on the direct relationship between humanity and nature.

By including society, many cultural components of biodiversity will finally be given the importance to which they are entitled. It also permits the reliance on science and knowledge when considering the intertwined relationship of the private, public, and natural elements. Ideally, a biodiversity action plan should strike a balance between public good and private good. The great philosopher Foucault (1994) would simply ask, Who determines the truth in matters of Biodiversity? And so, inspired by science and philosophy, and in a search for who should take responsibility for the powerful resources of genetic biodiversity, this paper explores the essential scientific responsibilities of both the State and the private sector.

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Watch for the Eco-Agriculture theme issue of *Global biodiversity* coming in 1998.

*Translated from French

IMPORTANCE OF SEEDS TO FEED THE WORLD

The global economic potential of the seed industry brings in about US $15 billion annually (Joly et Ducos, 1993). Based on genetics, this industry draws on the knowledge of many fields in order to market better performing varieties that meet the needs of food and agriculture (St-Pierre and Demarly, 1993). Thus, genetically enhanced wheat and rice varieties today supply more than 50% of the energy consumed by people. The genetic improvement of corn, barley, oat, sorghum, and millet has been so fantastic that more than 50% of the protein consumed on Earth are the product of less than ten species of grasses.

The industrialization of traditional agriculture has, however, progressively isolated the *in situ* genetic diversity of wild endemic grasses from the *ex situ* diversity of seed collections. St-Pierre (1996) considers that herein lies the root of a cultural and economic break brought about by the industrialization of crop seeds. Instead, the diversity of seeds should be linked to the diversity of North American endemic grasses that, to this point, have been little studied and used by the research scientists working in the seed industry. Interspecific hybridization and other modern biotechnologies could allow the development of the current diversity of cultivated grasses and further improve food crops without interfering with the health value of food.

How will we feed a world soon to hold 10 billion people? The answer lies in a harmony of efforts: new research, development of seed banks, and the conservation of endemic biodiversity.

In keeping with a recent Food and Agriculture Organization of the United Nations (FAO) report (1996), we would first like to reassert that plant selection has succeeded in increasing agricultural output. We also support the efforts made towards research and conservation of biodiversity — essential factors in feeding a world soon to hold ten billion people. To better accomplish this enormous task, the State has to better focus its research efforts on seeds and transplants.

After reviewing the global challenges facing biodiversity, we will examine the provincial role (Quebec) and the federal role (Canada) in the global community of conservation and use of biodiversity. What are these governments doing to protect, evaluate, and disseminate the genetic diversity of plants? What are they not doing? Shouldn't the public's endemic biodiversity and the biodiversity contained within the private sector's seeds and transplants be connected together in a more satisfactory way? As societies, we must increase our knowledge of all aspects of biodiversity along with an ambitious action plan.

GLOBALIZATION OF GENETIC RESOURCES

The United Nations Convention on Biological Diversity was adopted at the Earth Summit held in Rio de Janeiro in June 1992. It is the product of 25 years of awareness-raising among many world organizations, including those related to agriculture such as the FAO and, in particular, the International Plant Gene Resources Institute (IPGRI). IPGRI, with ties to FAO, has given itself the task of making the genetic diversity of plants more accessible. Eventually, similar structures for animals, microorganisms and fish should complement this task. The various sustainable farming systems will therefore have at their disposal a more complete pool of genetic diversity that will permit further development of an improved and more productive agriculture. In general, we expect that the conservationist will look after the *in situ* conservation of genetic biodiversity while the research scientist will protect *ex situ* seed collections at the same time as seeking out new knowledge about the genetic makeup of nature.

At the global level, seed collections allow plant breeders to freely exchange the best genetic material available. The importance of cereal seed collections, for instance, is shown in Table 1. Kept in freezers, these specimens are often considered redundant because plant breeders seem to prefer working with genetic material already developed by one of their colleagues. However, the collections are invaluable for both the current generation and future generations. Using the collections, scientists

Species	Number of samples	Organization	Worldwide % of samples
Wheat	774,500	CIMMYT	13%
Barley	485,000	Canada	14%
Rice	408,500	IRRI	20%
Corn	277,000	CIAT	12%
Beans	268,500	CIAT	15%
Soybean	174,400	China	15%
Sorghum	168,500	ICRISAT	21%
Brassica	109,000	India	16%

Table 1.
Main seed collections of the world and organizations responsible for their conservation. (Source: WIEWS database and CGIAR-SGRP Genebank Review <http://web.icppgr.fao.org/CPGR96/CPGR6.2/tab2.1.html>)

could evaluate the genetic, agricultural, pathological, and industrial potential of this material, but the research methods to do so still need to be improved. Unfortunately, since information obtained from such evaluations would remain free-access public property, the private sector research scientists show little interest in these collections. The state, specifically on the federal level, must therefore gather and disseminate a vast amount of diverse information on the biodiversity contained in their seed banks. Canada could also ensure the enrichment of these large public collections through *in situ* conservation of the biological diversity of endemic species. It could also employ the numerous biotechnologies productively used in the seed industry to enrich the diversity found in nature and thus lead to productivity gains.

According to many observers, we are currently witnessing losses of irreplaceable *in situ* diversity due to the very progress of agriculture and the resulting destruction of grassland and woodland ecosystems. A recent FAO report (FAO, 1996) thus stresses the urgency of enriching these seed collections. *In situ* conservation has unparalleled and real economic advantages. However, climate disruption and increased land use can endanger this approach; it must therefore be supplemented by *ex situ* conservation. Given the present level of knowledge, it appears that only costly seed collections can allow the safe conservation of plant genetic diversity. However there are many complex challenges related to the storing of *in situ* genetic diversity in *ex situ* collections of which we — whether we are scientists, farmers, or just ordinary people — need to be aware.

In keeping with the Convention on Biological Diversity, the responsibilities of governments must be separated from those of the seed companies. To find original solutions to paying for the conservation of biodiversity, a new conceptual model must be developed — one that reconciles the long-term perspective of nature with the short-term perspective of society. For example, today's economists do not have a model to evaluate the worth of current investments that will only be recouped in a few hundred years. An international collaboration of scientists and humanists is needed to tackle the conservation of biodiversity using the basic triptych model mentioned above.

ACTION PLANS FOR QUEBEC AND CANADA

There is a long way to go before enacting global laws and regulations that will ensure the sound management of the biological resources and biodiversity of the planet. While waiting for these global, science-based solutions to be found, each and every state must assume its responsibilities for *in situ* conservation as well as *ex situ* collections. States can exercise their responsibility and power through laws and regulations, and also through research and education. The emergence of private high-performing technologies, well adapted to the seed industry, also deserves particular attention (St-Pierre et al., 1996). Here is a quick glance at the recent solutions that Quebec and Canada are offering to the biodiversity conservation problems (Supply and Services Canada, 1995; Environnement et faune, 1996a; 1996b; Interdepartmental Committee on Biodiversity, 1996a; 1996b).

The provincial level: Quebec

Quebec's biodiversity strategy and action plan are ecosystem-based, and as such, they allow for the

preservation of biodiversity in the five main ecological regions of the province (Figure 1), thus safeguarding more than 1500 plant species endemic to North America. By doing so, it should then be possible for the plant breeder to use this rich genetic diversity, which spans everything from the species of the deciduous forest to the species in the fragile and precarious tundra. Part of the action is geared to increasing citizens' knowledge about the treasures hidden in these regions. This improved awareness and partnership will increase the chances to develop varieties that meet humanity's needs. It may simply put pressure on conservationists to reach decisions. At Laval University, scientists are trying to enhance crop diversity by introgressing genes into wheat varieties that have been discovered in the endemic grasses of Quebec — genes for resistance to viruses, moulds, and the severity of winter. To us, Quebec's biodiversity strategy is still timid as far as the inventory, evaluation, collection, conservation, and development of crop diversity is concerned. While it is important to preserve biodiversity *in situ*, it is just as urgent to aggressively use seed collections to meet agricultural and forestry needs. In order to share the wealth of biodiversity equally with all citizens, we really have to better understand it.

The federal level: Canada

Canada's action plan duplicates provincial biodiversity conservation efforts. Its strategy, also ecosystem-based, parallels Quebec's. Unfortunately, plant breeders' collections of crop and forest plants and the mechanisms required for genetic material exchanges are cast aside in the *Federal Report on the Implementation of the CBS — Flora and Fauna* (Interdepartmental Committee on Biodiversity, 1996a). Figure 2 illustrates the primordial need to implement *ex situ* conservation in Canada. Federal and provincial plant breeders and the majority of those working in university settings and in the private

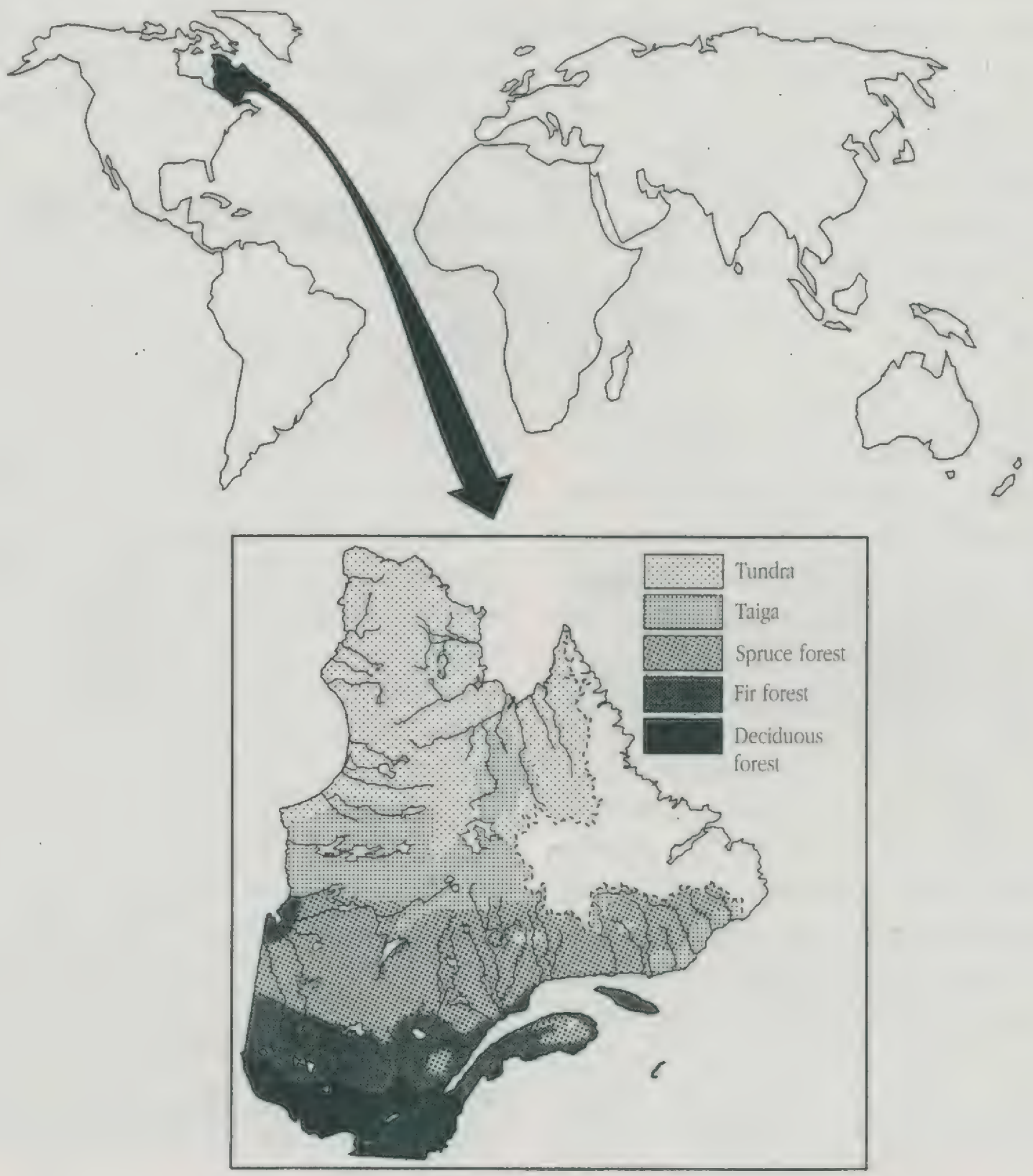


Figure 1. *In situ* conservation of genetic resources in the five vegetation zones of Quebec.

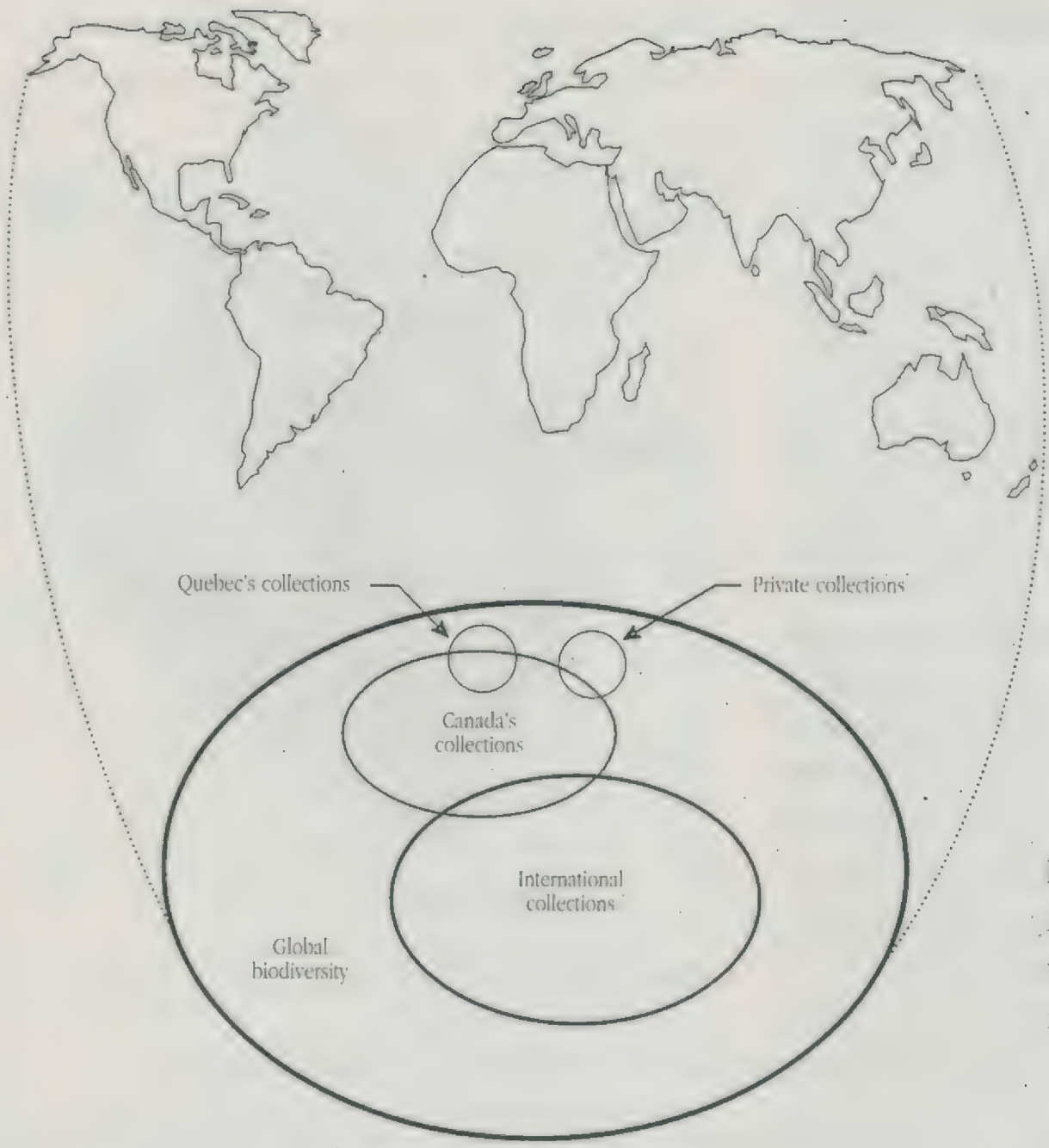


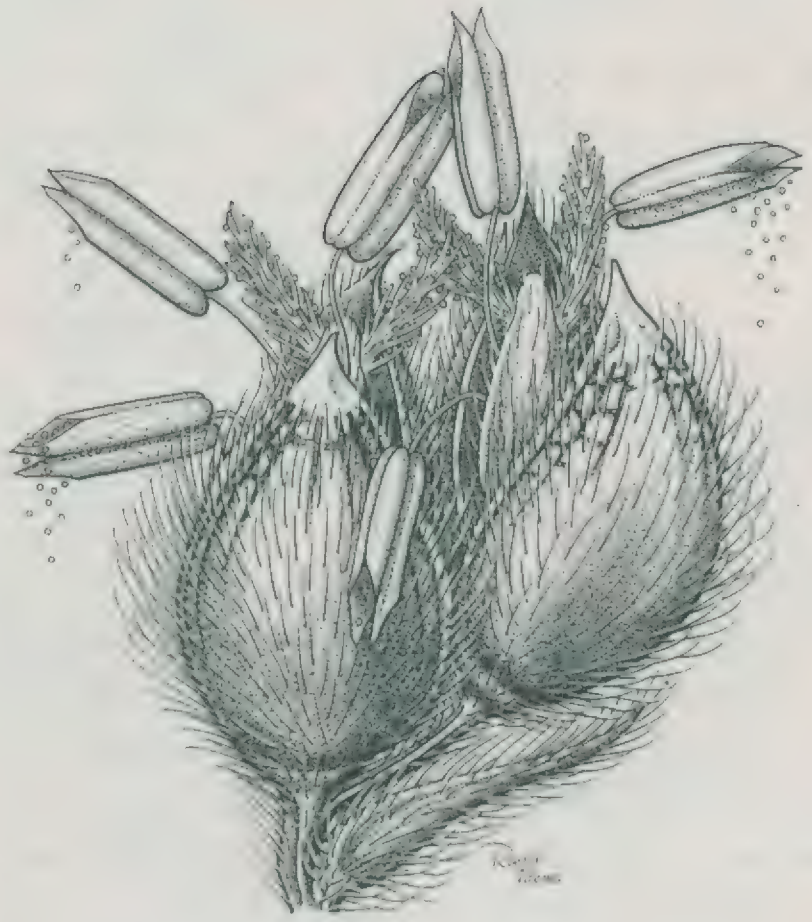
Figure 2.
Ex situ conservation of worldwide genetic resources in seed collections.

sector already allow for the use of their seed collections in hybridization, in return for the acknowledgement on the origin of the material. Private plant breeders already benefit from this "free" exchange. Does the reverse happen? For example, will the registered genes and the rapeseed varieties resistant to atrazine, developed by the private sector with the help of biotechnologies, as well as the transfer of genes through *Agrobacterium tumefaciens*, be as freely accessible?

There is no doubt that the principles presently used for sharing genetic biodiversity need to be fine tuned. Legislators need — and will always need — to restore the balance between the right to private property and the right of society as a whole. It is the duty of research scientists to better highlight the urgency and the potential of a more universal balance based on knowledge and science, *not* only on a superficial or dogmatic political will. We thus propose that the provincial and federal biodiversity strategies complement each other better and put more emphasis on seed collections and on the research efforts of the profitable seed industry.

We must build upon and modernize the inventory, collection, evaluation, conservation, and development of the genetic diversity of the species cultivated by humanity over the last 10,000 years. We believe it is up to Canada to support and fund an *ex situ* approach and to let the provinces bear the responsibility for the sustainable, fair, and equitable use of endemic resources. We hope that the new genetic resources conservation site in Winnipeg, Manitoba will be staffed by dedicated and imaginative personnel in order to make these rich collections even more accessible. Despite the fact that seed banks, diversity repositories, plant breeders' collection conservation nodes, and protected areas have already been built, the *ex situ* conservation objectives, even though they are duly stated in Canada's strategy (Table 1, page 3, Supply and Services Canada, 1995), are neither mentioned nor explained in Canada's proposed *action plan*. The action plan should take into account advice from the Expert Committee on Plant and Microorganism Gene Resources, established 25 years ago, which is already coordinating the conservation actions taken by Canada. Other committees were also established a few years ago to look after animal, forest, and fish gene resources. All of us in society must demand that politicians propose realistic action plans and ask research scientists and farmers to make the budget choices regarding the industrialization of crop seeds.

THE DISTINCTIVENESS OF CROP SEEDS

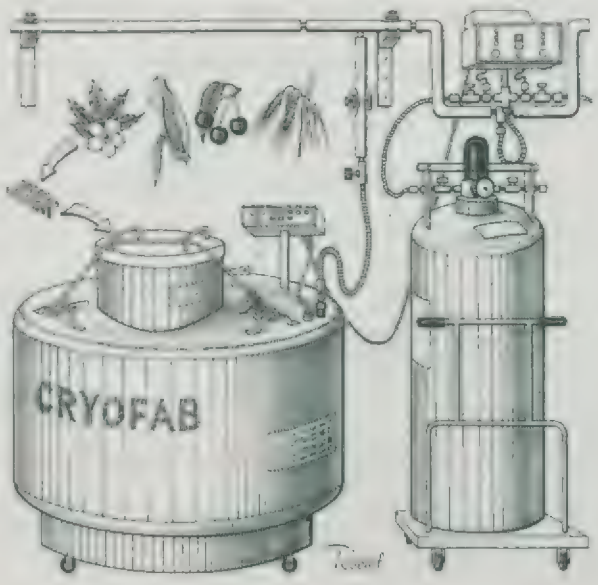


Part of a sorghum seed head.

According to research scientists, new and high-performing genetic combinations will be produced in the laboratory in the next century, thanks to biotechnologies (St-Pierre and Demarly, 1996). These major shake-ups in the various usage of Canada's natural heritage will be reflected in a seed industry that will be renewed from private capital. The truth imparted by the power to modify life will rapidly impact on the seed industry and thus on society. To better understand the world's plants and animals, the study of genetic diversity must go on. And yet there remain some questions difficult to answer.

First, how do we finance the conservation of endemic genetic diversity? How can we learn more about species through phytogenetics? The conservation of diversity is still possible in areas that are little disturbed by humans. As the Quebec government appropriately proposes, then, the time has come for each state to protect and study closely its own regions and ecosystems and species. Before all else, the conservation of biodiversity is the conservation of habitats, without which species could not survive. This first tier, to be called "An heritage for our descendants," should be understood, accepted, and realized through a straightforward comprehensive plan and life-long education programs offered by the various stakeholders of each region, including aboriginals. Complemented by scientific research, the conservation of endemic species will thus be carried out with a minimum of regulations and a maximum of educational efforts.

Second, can we protect the biodiversity of crop plants and forest tree species in the same way? The answer is no. The conservation of crop plants must be done through seed collections while forest species are easily protected *in situ*, in natural stands. Canada should give priority to the protection of crop plants and forest species coming from other continents in conjunction with supporting the provincial *in situ* conservation plans. After all, provinces harbour numerous species related to crop plant species. In turn, Canadian seed collections will be enriched and thus contribute to the development of international collections. Canadian law must strictly rule on international exchanges of genetic material. At the same time, the private sector is eager to put all expertise in selection and biotechnologies at the disposal of agriculture in exchange for property rights. In this context, one must remember that the social goal of more sustainable agriculture will lead to new requirements in terms of genetic biodiversity. New measures of harmonization between private and public goals are essential and urgently needed. All these measures of harmonization between private and public responsibilities are essential and they should ensure a smooth shift to sustainable agriculture.



Cryopreservation of seeds: the most expensive and time-consuming approach.

Third, will both levels of government assume responsibility for the search for increase knowledge of genetics and ecology? This new knowledge is essential for a productive and prosperous society. For example, the introduction of new genes is essential to the continued development of desirable species such as soybean, canola, and triticale. Developing the science of interspecific crosses, *in vitro* as well as molecular, supports new directions. Introgression, or the incorporation of genes of one species into the gene pool

of food and cultivated plants, is a strategy that could lead to the cultivation of fruit-bearing and ornamental species, vegetables, and cash crops in northern regions (Simmonds, 1993). It is necessary to develop new ways to carry out the inventory and evaluation of crop species diversity, quantify the scope of this diversity, conserve genes, and develop new strategies for the production of seeds and transplants. A better understanding of biodiversity will enable us to take into account the top problem-oriented priorities of food and agriculture. For example, we think the genetic biodiversity of the some 250 grass species presently under study in Quebec could significantly contribute to the development of the seed industry and feed crops throughout the world. A more efficient use of local biodiversity could be a new way to improve the resistance of our crops to local diseases, climates, and soil problems. Vigorous, resistant crops produced from this enriched genetic background could contribute to the shift toward sustainable agriculture.

CONCLUSIONS

In conclusion, we believe:

- there is an urgent need to develop education and research programs for training new research scientists in the very broad field of biodiversity;
- each Canadian at the local level must be made aware of the importance of biodiversity and must be involved in protecting it;
- the government of Quebec must be involved in the inventory, preservation, and evaluation of *in situ* genetic diversity;
- the government of Canada must complement the provincial and territorial conservation efforts by *ex situ* conservation efforts across Canada (see Table 2 for a summary of the main responsibilities and duties of the State);
- the procedures for studying and using biodiversity must be upgraded;
- the body of laws on seeds and transplants (breeders' and farmers' rights, intellectual property rights, and citizens' rights) must be modernized, harmonized, and implemented; and

- Quebec shall carry out the inventory, evaluation, and conservation of *in situ* genetic diversity.
- Quebec shall inform and promote awareness of its citizens about the cultural aspect of biodiversity.
- Canada shall carry out the inventory, evaluation, conservation, and enhancement of *ex situ* genetic diversity.
- Canada shall upgrade, harmonize, and implement its body of laws on seeds, breeders', and farmers' rights, intellectual property rights, and citizens' rights with respect to biodiversity.
- Canada and Quebec shall harmonize the financing of research stemming from the industrialization of seeds and transplants.
- National and international seed companies shall develop and valorize the numerous uses of genetic diversity in agriculture, forestry, and recreation.
- Industrialized countries shall finance basic research on biodiversity (methodology, genetics, biotechnology, legal, and social studies) and training of young research scientists, taking into account the need to thoroughly understand the relationship between humans, nature, and society, and cooperate with developing countries and share benefits with them.

Table 2.
Main responsibilities of the government of Quebec and Canada with respect to plant genetic diversity.

- the responsibilities of the public and private sectors need to be defined as far as agricultural and food economics are concerned.

As a complement to the utilitarian aspect of biodiversity, there are also educational and cultural benefits. Although an age-old respect for nature is already shared by *informed* citizens, who are respectful and aware of the importance of biodiversity in its broadest sense, there is much educational work to be done. We hope that a great number of Canadians will generously involve themselves in this endeavour so that humans, nature, and society may exist in harmony. Then, truly, the knowledge derived from both the natural sciences and social sciences will be integrated. Only a universal concept based and backed on these truths will provide for a sound and responsible management of biodiversity.

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THE KIDNEY FOUNDATION OF CANADA

Developing a biodiversity database in Leicestershire

Ingrid Birker[1] and Ian Evans[2]

In Britain a wealth of environmental information has been gathered by biological recording, the practice of collecting species, and habitat information. Through the data associated with their collections, local and regional museums have long been a major source of biological records. Using non-specimen based records as well as collections records, museum biologists are now able to make informed recommendations on environmental planning and conservation. Today there are approximately 50 museum-based or museum-linked biodiversity database centres in Britain (Berry, 1988). This paper focuses on one county museum's Ecology Unit and its related Biology Section; it describes the origins and development of the section, as well as the systems that have been set up to collect and manage the database; it documents the valuable societal role of museum biodiversity databases. [D.E.M.]

INTRODUCTION

The Leicestershire Museums Service and its predecessors date back to 1849. Like many other local authority museums in Britain, the Service has been involved in species recording for over 100 years. Because of its work, we know that a total of 92 species of Leicestershire flowering plants and ferns have become extirpated since 1740. We also know that before 1940 approximately 71% of the county was covered in permanent grassland, a rich habitat resource; today only 17% of Leicestershire is grassland (Primavesi and Evans, 1988). Biological recording thus provides us with a record of local land-use changes and allows us to follow the resulting effects on biodiversity; it also enables museum naturalists to monitor global environmental changes at a local level. Because accurate and precise records and maps pinpoint threatened species and the deteriorating condition of habitats, they become essential tools to advise planners, conservationists, and others interested in broader environmental issues.

It is hoped that this profile of the Leicestershire Museums Service will inform readers on the methodology of creating a biodiversity database in a museum setting, and more importantly, show its relevance to the modern world. Biological recording is not a trivial and/or incidental adjunct to natural history work in a museum. Rather, the management and deployment of biological records, whether stored on paper, film, or in the traditional way, as specimens, now constitutes a significant part of the work of the museum naturalist and is an important contribution to the survival of our own life-support systems on this planet.

THE LANDSCAPE AND THE MUSEUM

In Leicester, responsibilities for biological recording are divided within the Natural Sciences Division of the Museums Service, although there is inevitable overlap between the two sections. The Biology Section, established in 1945, handles species recording (from specimens in the collections and sight records) and the Ecology Unit, formed in 1985, handles the site recording. The two sections are physically separate, but their databases are linked by computerized cross-referencing systems. These links, in large part, ensure the relevance and utility of the records in a diversity of situations.

In common with most of lowland Britain, Leicestershire is largely a man-made landscape. Only 2.5% is woodland, making Leicestershire the second least-wooded county in

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Figure 1. In common with most of lowland Britain, Leicestershire is a man-made landscape. Only 2.5% is woodland, making it the second least-wooded county in England. This aerial photo shows Narborough Bog, a wet woodland extinct since the late 1970s.

England (Butlin, 1988). The Ecology Unit's main focus is the 87.5% of the county outside of the built-up areas, though there are substantial numbers of records relating to both species and sites within the built-up areas (see Fig. 1).

Approximately 300 hectares of Leicestershire land is taken up by "development" each year (Evans, 1988); most of it is subject to planning permission, which is when the Ecology Unit gets involved. The Ecology Unit advises the planners where development should not be allowed or on ways of ameliorating the damage caused by unavoidable development. This type of work requires a comprehensive database of information, a network of contacts with voluntary conservationists and naturalists, and professional links with the planners working for the local authorities.

The Leicestershire Museums Service is not the only organization involved in biodiversity survey work in the county. Several independent natural history societies and conservation groups also organize recording schemes. The Ecology Unit holds copies of the reports by these independent groups and the archival material relating to the reports.

Two liaison groups meet about once a month to ensure that the variety of bodies, both governmental and non-governmental, that are involved in wildlife management or environmental protection in the county do not duplicate effort or give conflicting advice. The Ecology Unit convenes one of these, the Ecological Sites Liaison Group. The other is convened by the City Planning Department and deals with ecological issues relating to land situated in or served by the city. Staff of the Ecology Unit serve on this second group.

THE ECOLOGY UNIT: SITE RECORDING

The work of the Ecology Unit revolves around a database resulting from a systematic ecological survey, parish by parish, of land-use and wildlife habitats. The parish is the smallest administrative unit in British local government. There are 286 parishes in Leicestershire that vary in size from less than 200 hectares to more than 2,000. Although the parish stores most of the specific information in the database, there are other sections relating to generalities or to large or linear features, such as reservoirs or rivers, that transcend parish boundaries.

The ecological survey began in 1976 with one part-time field ecologist and with grant-aid from the Nature Conservancy Council (Evans, pers. comm., 1988). It first concentrated on the detailed county-wide survey of sites of human ecological interest, such as ancient woodlands (see Fig. 2). In 1979, in response to a major planning inquiry, the current ecological site evaluation or grading system was devised, in which sites are ranked as being significant at the county, district, or parish level. These levels correlate with the three tiers of local government. Also in 1979 the pace of recording was stepped up and the emphasis was shifted to the systematic coverage of poorly known parishes.

During the first season of professional field-by-field surveying, many previously undocumented sites of considerable ecological significance were identified, including Muston Meadows, which is now the county's

Figure 2. Early site recording (early 1970s) focused on significant sites such as ancient woodlands. The criteria for evaluating a site are diversity and rarity at both community and species level. The evaluation system relies on individual specialists with extensive knowledge of the county's ecology. This museum botanist is examining a non-suckering *Ulmus*.

Figure 3.
An ecological site map of Dunton Bassett, a small parish southwest of Leicester. The location, extent, and relative importance of all known sites of ecological significance can be clearly marked with different colours and site maps, usually at the 1:10,000 scale, can be manually produced and colour-copied as required (Evans 1989a).

Figure 4.
During the first season of formal field-by-field surveying (1979) using the parish as a survey unit, many unknown sites of ecological significance were identified including the woodland circled on the bottom left. This is now the county's only National Nature Reserve with statutory protection.

only National Nature Reserve (Evans, 1985) (See Fig. 4). To give you some idea of the magnitude of the site-recording task, it has been estimated that this field-by-field survey, which was completed in 1991, has information to a greater or lesser degree on all of the 50,000 fields, 100,000 hedges, 17,000 ponds, 1,200 woods and spinneys (small woods or thickets) and 1,000 kilometres of roadside verge, which are some of the constituents of the Leicestershire landscape (Evans 1989a, p. 2).

The process of evaluation involves a comparison, across the county, of like with like: hedgerows with hedgerows or ponds with ponds. Generally speaking, up to 10 of the best sites within any one habitat category are rated significant at county level, up to a further 90 as significant at district level, and any others that are worth noting in the local context are rated significant at parish level. The criteria for evaluation are, basically, diversity and rarity at both community and species levels (Evans 1981). At county level there is a strong correlation with the grading systems used by national conservation agencies across the country.

The "Site Alert" maps produced by the ecological evaluation (see Fig. 3) are available to planners and conservationists and allow them to predict the impact of possible developments. The gradings have no legal status in a national sense, but protection, wherever possible, particularly for county and district level sites, is now written into the structure and local plans on which planning decisions are based.

HOW SITES ARE SURVEYED, RECORDED AND EVALUATED

The methodology used by the Ecology Unit's survey team evolved in the late 1970s in consultation with the Nature Conservancy Council and may be described as a

Figure 5. The Phase 1 or field-by-field survey map illustrating all the land-use features and different habitats of areas not built up around Dunton Bassett.

combined Phase 1/Phase 2 survey. The Phase 1 elements of the survey record the location and extent of the different habitats occurring within a given unit area, usually a parish. It involves a general ground survey that gives an indication of the land cover or use and vegetation in every parcel of land (see Fig. 5). As the need arises — for instance, if surveyors discover something unusual or interesting — the Phase 2 survey is undertaken at the same time. A Phase 2 survey entails a more detailed recording of the vegetation of sites together with the gathering of readily available information on the fauna (see Fig. 6).

The information from surveys is recorded in colour on copies of the 1:10,000 Ordnance Survey maps of the area concerned. The survey notes are supplemented by colour transparencies, whether of specific sites or to record the general appearance of the landscape. The Ecology Unit also holds some 2,000 aerial colour transparencies taken from the Museums Service plane, which provide a further source of data illustrating landscape change (Evans, 1985). All survey work is carried out from public rights-of-way or with the express permission of the owners or occupiers. Members of the survey team carry an official letter from the Museums Service, which explains the purpose of their investigations and serves as an introduction.

ECOLOGICAL SITES DATABASE AND INDEX

The database occupies some 30 metres of filing cabinets in the Ecology Unit. It is elegantly ordered by a hierarchical numbering system that uniquely identifies sources down to the level of a note in an individual document. This allows the rapid retrieval of information on over 5,000 sites in Leicestershire so far identified (Evans, 1985). The content of individual sources in the files (maps, lists, notes, photos, etc.) is summarized on the computerized Ecological Sites Index. Much of the information about sites is necessarily coded for speed of input and brevity.

The Ecological Sites Index is carried on the County Council's Sperry 1100 Series mainframe computer using MAPPER, a fourth-generation relational database (Evans, 1986; in press). It is no coincidence that the County Council mainframe also serves the administrative needs of the Museums Service, and houses the collection documentation system; the Service now has some 40 interactive terminals.

The Ecology Unit uses the Index to locate bits or masses of information quickly and then to manipulate (sort and search) this information. Searches can provide either wide-ranging or very specific data. A search for all

references to ponds, for example, can be narrowed by adding one or more criteria, such as "with amphibian interest," "in a specific district," "surveyed since 1980," or "for which photographs exist." The Index can then sort these by grid reference so that sites can be mapped, or by source reference number so that detailed information in the site files can be consulted.

The Ecology Unit is the only organization in Leicestershire with a comprehensive publicly accessible ecological database. It employs four full-time staff and a variable number of contractors, and the Unit deals with 600 consultations per year. Forty percent of the consultations relate to specific planning applications or to the preparation and revision of County Structure Plans as well as Local Plans. The Ecology Unit comments on all major developments that may possibly have an ecological impact, such as new roads, mineral extraction, and waste disposal applications. A further 20% of the consultations emanate from conservation organizations at a county or national level, and the remaining 40% from a wide variety of organizations (such as the Farming and Wildlife Advisory Group and the national Ministry of Agriculture, Fisheries and Food) and individuals who have an interest in wildlife and nature conservation in Leicestershire (Evans, in press).

By and large, the Ecology Unit handles consultations and routine inquiries free of charge for County or District Councils, conservation organizations, educational institutions, or bona fide researchers (Evans, 1989a). However, inquiries from the private sector, such as contract ecologists working for developers, are charged at a standard rate for the extraction of information, though not for the information itself. Aside from handling formal inquiries, the Ecology Unit acts as a general clearinghouse for ecological inquiries that are not site-related or are of a more general nature.

THE BIOLOGY SECTION: SPECIES RECORDING

There are now more than one million records of the county's fauna and flora held by the Biology Section, representing over 48 taxonomic groups. Eighty percent of the species records date from 1948 and are further supported by voucher material in the collections, which amounts to over 300,000 individual specimens from the

25. SP 550 917 Pond, 25m x 10m, in arable field. Depth in excess 0.6m. Site is unshaded; dominated by *Equisetum fluviatile*; some *Lemna minor* present. Marginals include *Glyceria fluitans* and *Phalaris arundinacea* var *picta*. Low gradient banks support *Epilobium hirsutum*, *Juncus inflexus*, plus two small shrubs of *Crataegus monogyna*.
Mallards.

26. SP 552 919 Mixed woodland; thin strip bordering Lutterworth Road. Two mature *Pinus sylvestris*, one of *Quercus robur*. *Crataegus monogyna*, *Rosa* sp., and young *Ulmus* sp. form the shrub layer. Dense field layer of *Rubus fructicosis* agg. and *Urtica dioica*.

27. SP 552 917 Mixed woodland; thin strip bordering Lutterworth Road. Mature *Fraxinus excelsior*, *Pinus sylvestris*, *Quercus robur*; plus numerous *Carpinus betulus* under 10m high. Understorey dominated by *Rosa canina* agg.; abundant *Ulmus* sp. Frequent *Crataegus monogyna*, *Sambucus nigra*. Also present, *Prunus spinosa*.

28. SP 546 913 Seasonal pond, 7m x 5m (winter), bordered by semi-improved grassland, note 30, to the south. Water flows into the pond via a drainage ditch. Depth 0.2m; site is poached by cattle. Frequent *Lemna minor*, *Ranunculus aquatilis*, *Veronica beccabunga*; abundant *Glyceria* sp. (*fluitans* group); locally frequent *Carmadine pratensis*. Present also, *Coronopus squamatus* and *Crataegus laevigata*.
Frogs and spawn noted.
Waterhen: one breeding pair.

29. SP 547 913 Drainage ditch, flowing into pond note 28. Water breadth 0.5m, depth 0.1m. *Glyceria fluitans* dominant with frequent *Apium nodiflorum*, *Veronica beccabunga*. Steep sided banks support abundant *Carmadine pratensis*, *Ranunculus acris*, *Ranunculus repens*; occasional *Centaurea nigra*, *Lathyrus pratensis*, *Lotus corniculatus*. Small *Crataegus monogyna* are sparsely distributed along the ditch.

Figure 6.
The survey map is supplemented by a detailed report describing vegetation and fauna.

county (Evans, 1989b). The biological records officer, recently appointed to the Biology Section, is, among other things, responsible for recording species.

Approximately 20% of the other two professional staff members' time is spent on species recording. This may entail the computerization of records, launching an amphibian survey, or answering a bat inquiry. Records are filed systematically by major groups (eg. Mollusca, Isopoda, Amphibia) and the sources for the records are kept and numbered in date order within these files. The files contain a diverse assemblage of sources, such as visiting experts or researchers, the Museum staff, the inquiry service, publications that contain Leicestershire records, and unpublished reports of field trips.

Some systematic files are much larger and more comprehensive than others are — the Lepidoptera Recording Scheme occupies 3 metres of shelf space alone! The records are organized by the Biology Section and, since 1970, have been maintained by a team of dedicated amateur recorders (Mathias, 1987). The Lepidoptera Recording Scheme was launched with a public exhibit; species recording cards were printed and are freely available for each of the major groups (butterflies, moths and micromoths). At present the cards are manually cross-indexed; eventually the information on species distribution maps will be summarized in the form of a published atlas.

In many of the popular groups, records are too numerous to be published in their entirety. They are, therefore, displayed in the form of dot maps, where each dot represents the occurrence of the particular species in a 2-km square of the National Grid (Fig.7). Such distribution maps provide a quick graphic method of spotting distribution patterns, serve as a reminder of habitat preferences, and indicate relative rarity or abundance. At the county level, they also complement the national atlases (10-km square distribution maps) produced by the Biological Records Centre at Monk's Wood in Cambridgeshire.

Sources of species records

Some groups, such as lichens or millipedes, require specialized knowledge, and so a proportion of the species records are derived from in-house or contract research funded by the Museums Service (with some grant-aid). For example, the North East Leicestershire Coalfield Report (Evans, 1979) required one-and-a-half

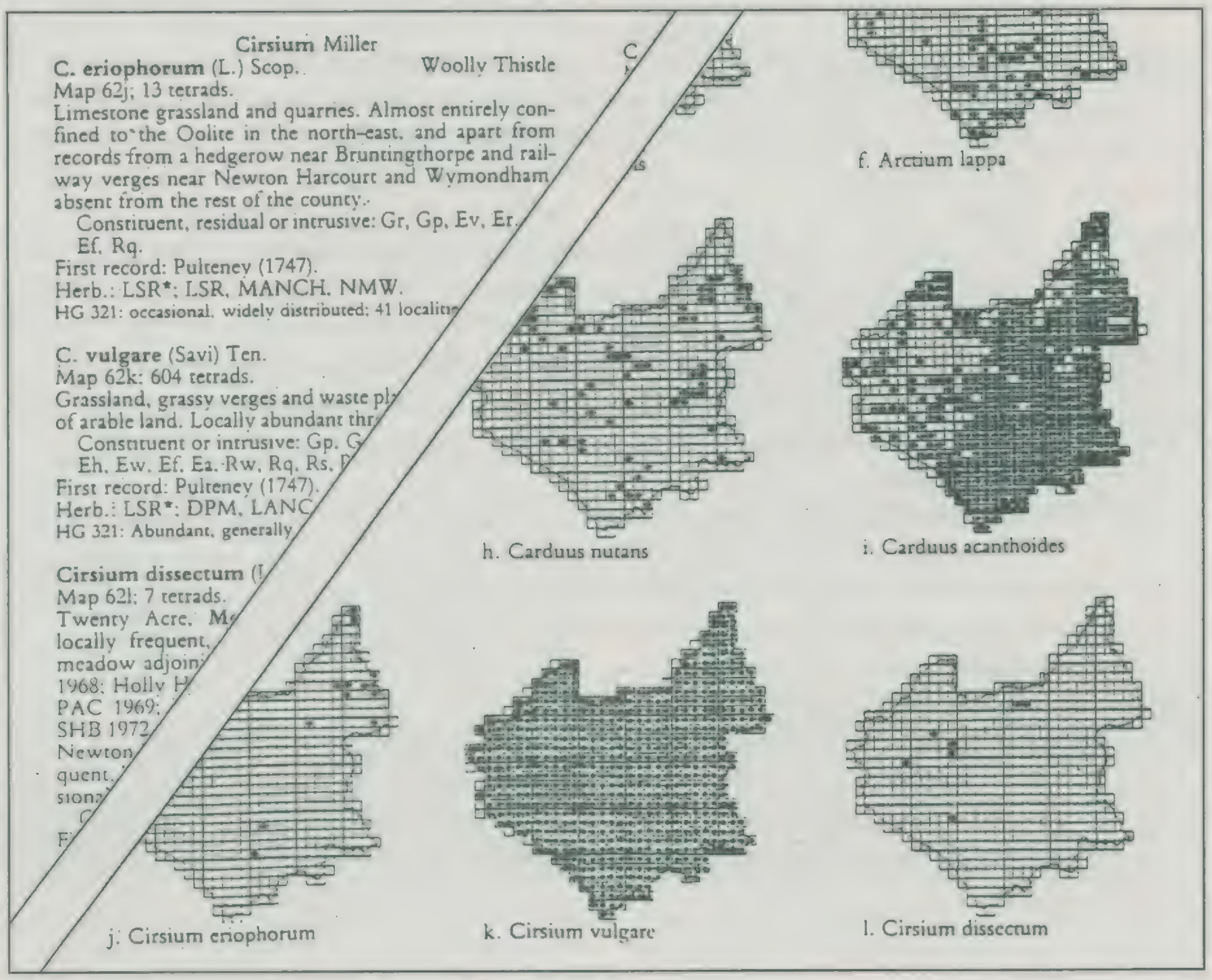
Cirsium Miller
C. eriophorum (L.) Scop. Woolly Thistle
Map 62j; 13 tetrads.
Limestone grassland and quarries. Almost entirely confined to the Oolite in the north-east, and apart from records from a hedgerow near Bruntingthorpe and railway verges near Newton Harcourt and Wymondham absent from the rest of the county.
Constituent, residual or intrusive: Gr, Gp, Ev, Er, Ef, Rq.
First record: Pulteney (1747).
Herb.: LSR*; LSR, MANCH, NMW.
HG 321: occasional, widely distributed; 41 localit
C. vulgare (Savi) Ten.
Map 62k: 604 tetrads.
Grassland, grassy verges and waste pl
of arable land. Locally abundant thr
Constituent or intrusive: Gp, G
Eh, Ew, Ef, Ea, Rw, Rq, Rs,
First record: Pulteney (1747).
Herb.: LSR*; DPM, LANC
HG 321: Abundant, generally
Cirsium dissectum (
Map 62l; 7 tetrads.
Twenty Acre, M
locally frequent,
meadow adjoin
1968; Holly H
PAC 1969;
SHB 1972
Newton
quent,
sion
C
F
f. Arctium lappa
h. Carduus nutans
i. Carduus acanthoides
j. Cirsium eriophorum
k. Cirsium vulgare
l. Cirsium dissectum

Figure 7. Species recording of popular groups is summarized on dot maps. This extract from the *Flora of Leicestershire* (Primavesi and Evans, 1988) shows the distribution of specific thistles mapped onto 2-km squares of the National Grid. Of the seven sites at which *Cirsium dissectum* was recorded, one was destroyed by the construction of a major highway but five are protected as Sites of Special Scientific Interest (SSSIs).

years of organized biological survey and research of three areas to the northeast of Leicester threatened by extensive coal mining. The report of the biological survey was noted as the most substantial ecological impact study with respect to any planning proposal ever undertaken by a British Museum Service (Boylan in Evans, 1979). Only one of the three proposed mines was built — the one that had the least ecological impact.

Another major source of species records is the substantial archives deposited by or inherited from local natural history societies. For example, the bird records of the Leicestershire and Rutland Ornithological Society, founded in 1941, have been stored at the museum since the mid 1960s. Approximately two-thirds of a metre of record cards are added each year, and most of the records may be made available to bona fide researchers according to procedures agreed to by the Society. However, records of some 15 rare or endangered species are kept separate from the general records and treated as "classified" information. These records may be consulted only with written permission from the Committee of the Society.

BIOSPIN

Computerization of the Biology Section's species records started in 1987. Aptly named BIOSPIN, the indexing system is compatible with the Ecological Sites Index and also operates on the County Council's Sperry 1100 Series mainframe computer using MAPPER. TAXOCHEC, a complementary system, acts as a dictionary file to translate species codes into species names with their authorities. The development of these systems at Leicester predated that of RECORDER, the national biological recording package. The transfer of data between the two systems is now being investigated.

Records can be entered into BIOSPIN in a variety of ways. A large number of records are already in the database that houses the Museum's computerized specimen catalogue. Data can be easily transferred or downloaded from the catalogue database to BIOSPIN when required. Records can also be entered outside office hours and at remote field locations using a portable personal computer. On average it takes about 30 seconds for an experienced operator to enter a one-line record onto BIOSPIN.

An addition to the computer facilities at Leicester is a mapping package called MAPICS, which can transform grid-referenced records of any kind into species and habitat distribution maps. This eliminates the tedious task of manually mapping records.

Use and cost of the species recording service

Computer manipulations such as "search" and "sort" are extremely useful for answering inquiries. The Biology Section deals with approximately 900 externally generated inquiries and identifications per year. Two-thirds of these relate to the fauna and flora of Leicestershire. In 1987, when the National Biological Records Centre at Monks Wood was compiling Muntjac deer *(Muntiacus reevesi)* records for a publication about the national distribution, a BIOSPIN summary of Leicestershire's Muntjac records was sent on disc. A similar listing has been prepared for all the Leicestershire reptile records; these were entered on BIOSPIN and then sorted and searched into separate species categories in order to answer an inquiry about the status and abundance of these particular species in the county.

The main factor limiting the wider use of BIOSPIN is the massive number of person-hours required to enter the accumulated historical data into the system. It is impossible to estimate what it has cost over the last 150 years to set up the database represented by the species records and voucher collections held by the Biology Section. However, given the staff time involved and the addition of computer costs, the calculated expense of maintaining the Biological Species Databank is currently about £20,000 per annum (1997 figure based on Evans, 1989b).

CONCLUSION

Museums have always been repositories for biological records through their specimen collections. In itself a museum specimen constitutes a biological record; its data label often contains additional information, such as the collecting site, the date of collection, the name of the collector, or the person who identified it.

There are several ways in which a museum can organize biological surveys. The staff may conduct survey work as part of their curatorial responsibility and organize site visits in a systematic and scientific manner. For example, an inventory of certain habitats, such as woodlands, can be intensively "worked" and recorded over a set time period. A structured approach to biological survey, such as that employed at Leicestershire, focuses effort and gathers a wide range of information from a Phase 1 field-

by-field survey of habitats to a detailed Phase 2 study, which includes the entire spectrum of all biological interest for sites worthy of special treatment.

Museum curators and managers of collections are also critical to a less formal, but equally important, recording scheme. In many British museums they have traditionally served as local experts and are often involved in naturalist societies and conservation groups. Their connection with these societies and groups encourages amateur naturalists to record species systematically and provide biological, ecological, and distributional information about particular taxa. In exchange for this "free" labour, the museum can organize and lead visits to under-worked sites, give site-survey training, and provide species checklists and pre-printed cards.

The more information the Biological Records Centre holds, the better it can serve its users. However, the information must be organized so that it can be accessed efficiently. Both the records and the expertise of professionals and amateur naturalists are best coordinated through a museum-based recording centre. There, records can be filed and cross-referenced and information can be accessed directly. In this way the centre acts as a clearinghouse for records; it is a link between the users and the generators of biological records and provides an archive for both. Without a formal centre to store and amalgamate records, a vast majority of data would be lost or at best scattered in scientific journals, society newsletters, and personal notebooks. Such a random system helps neither species nor ecosystems and thus poorly serves the protection and conservation of biodiversity.

Working together, local Biological Recording Centres such as the Leicester model can help to streamline biological information in order to authenticate claims of environmental destruction or exploitation. Public interest in environmental conservation has stimulated an increasing demand for reliable information about their natural heritage. Museums are well placed to fulfill this demand: they are autonomous public institutions and their information "should be" more neutral, objective, and accessible than that of planning department ecologists or other biased parties. If the ultimate objective of biological recording is to understand the fragile dynamics of the natural world in order to conserve it, then surely museums can further develop this form of "collection management" even though it is not necessarily specimen-based.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the Canadian Museums Association for Ms. Birker's Mid-Career Development Grant that allowed her to conduct research under the auspices of the Leicestershire Museums Service during the late 1980s. The Leicestershire Museums Service kindly provided the photos and figures.

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Facing the challenges of invasive alien species in North America

Ian E. Efford,[1] Constantino Macías Garcia,[2] and James D. Williams[3]

This article has been adapted from a statement of concern that was prepared by an international panel of scientists from Mexico, Canada, and the United States. These scientists attended a "Workshop on North American Non-Indigenous Freshwater Fish" sponsored by the Commission for Environmental Cooperation in April 1996. The statement was intended to draw attention to the importance of developing a coordinated North American approach to address the problems arising from the introduction of alien species, many of which reproduce and spread within and beyond the ecosystems to which they are introduced. In preparing the article, the authors recognize that some introduced species, such as those used in agriculture and forestry for biological control, have been of great benefit to humanity and that most introduced species have not had serious negative consequence. However, as the authors point out, it behooves us all to be vigilant about introduced species, and in the future, to prevent further introductions — especially in our lakes and rivers. [D.E.M.]

"Introductions, like extinctions, are forever."

J. Ellen Marsden

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INTRODUCTION

Alien species, sometimes referred to as non-indigenous, exotic, or foreign species, often behave as a particularly. insidious form of biological pollution. Unlike chemical pollutants, which typically degrade and dilute but do not increase by themselves, many invasive alien species reproduce and spread with unpredictable and irreversible consequences. Once established, these species can be a permanent problem: they can prey on native species; compete for food and space; degrade habitats and food webs; degrade water quality; and often transport and spread diseases and parasites. All too often the results lead to:

- the loss of genetic, species, and ecological diversity;
- the replacement and extinction of native species;
- decreased biological productivity;
- costly control programs;
- lost food and wood production; and
- the loss of culturally and economically important species.

In April 1996, attendees at the "Workshop on North American Non-Indigenous Freshwater Fish" focused on freshwater fish as a starting point for a discussion on invasive alien species in general. Why? Because the ecosystems most vulnerable to species introductions include small oceanic islands, alpine areas, lakes, rivers, and springs or other restricted bodies of water with endemic species. Also, in North America, freshwater systems contain a disproportionately high number of species at risk. One of the major factors putting these species at risk is the negative impact of introduced alien species. The fact that, for the most part, there is a reasonable amount of information available on introduced freshwater fishes made this a logical place to start.

ACTION TAKEN TO DATE

The governments of Canada, Mexico, and the US recognize the urgent problem of invasive species and the need to improve our understanding and control of their effects. In 1992, the three countries participated in and signed the Convention on Biological Diversity. In addition, each government has begun to address alien species issues within their respective countries.

- In Canada, the federal department of Fisheries and Oceans has developed a draft National Policy on Introductions and Transfers of Aquatic Organisms. This policy will establish the criteria for the intentional introduction and transfer of aquatic organisms. Canada has also initiated discussions on a national strategy on alien species.
- In the US, there is legislation pending before Congress entitled the *National Invasive Species Act*. This Act amends and re-authorizes the *Non-Indigenous Aquatic Nuisance Prevention and Control Act* of 1990 (Public Law 101-646) and expands its scope to include all US waters. In particular, the bill establishes a national, voluntary ballast-management program for vessels visiting US ports to reduce the possibility of ballast transfers of alien species.
- In Mexico, environmental legislation states that biological conservation should include the protection of both evolutionary processes and genetic diversity. Unfortunately, it does not yet recognize the problems posed by introduced species and in its definition of wildlife, includes any introduced species whose population in self-sustaining.

The above agreements do not contain a key clause: obligatory consultation with neighbouring countries when species are intentionally introduced into shared water bodies or drainage basins. There are several cases where such international dispersal has resulted from an introduction in a given country, e.g. the mosquitofish (McAllister et al, in press).

Once introduced, the costs of controlling alien species are high. The costs to control zebra mussel are expected to be $400 million per year in the Great Lakes basin alone.

COSTS OF EXOTIC SPECIES

Of the thousands of alien species on the North American continent, some are beneficial, especially in agriculture. About 15%, however, have been identified as having severe, unwanted economic costs. In the last century, in the US, 79 of 675 species have caused an estimated $97 billion in damage to natural resources and industrial productivity (US Congress Office of Technology Assessment, 1993: Table 1-2). Future costs to control or mitigate the effects of 15 existing alien species in the United States and the economic losses associated with these species are expected to exceed $100 billion over the next 50 years (US Congress Office of Technology Assessment, 1993). For example, the zebra mussel is expected to cost about $400 million per year in the Great Lakes Basin alone. These figures imply a heavy economic burden, are believed to be "chronically underestimated," and do not take into account future introductions.

The 1993 US Office of Technology Assessment report revealed that the history of exotic species in the US spans more than two centuries and includes at least 4,500 plant and animal alien species. In Canada, 30% of the 4,153 vascular plants are exotic (Mosquin, et al 1995). Interestingly, rates of introduction of alien species increased dramatically around the turn of the century when ship travel increased. More recently, a significant rise in world trade and travel has generated a new outburst of species introductions to the continent. If continued, native biodiversity will be seriously damaged and some of our more vulnerable rare and endemic species will become extinct, replaced by a few widespread species in a more globally homogenized biological environment. The government report concluded, "the total number of harmful alien species and their cumulative impacts are creating a growing economic and environmental burden for the country." Of course, this problem of species introduction is not restricted to North America; it is a worldwide phenomenon that imposes a financial burden on all affected countries.

EFFECT OF INTRODUCTIONS ON NATIVE BIODIVERSITY

Alien species are a major threat to the natural biodiversity of a region and especially to vulnerable endemic species. Preservation of biological communities, therefore, usually involves protection of entire ecosystems. Such preservation is an international concern. Thus, the Convention on Biological Diversity (CBD) states that:

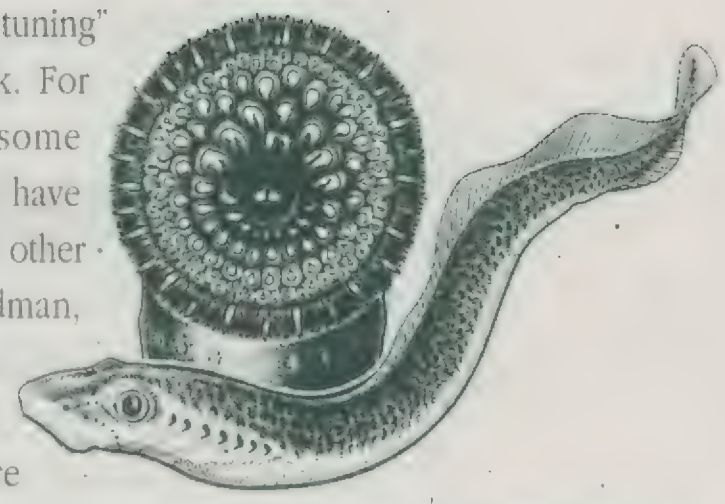
"Each Contracting Party shall, as far as possible and appropriate...(b) Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species."

There is considerable evidence from all three countries that some of the valuable natural resources in our freshwater systems are being lost because of competition or predation by introduced species. For example, one source of species introduction is the intentional stocking and transplanting of species into new geographic regions. Such transplants are often intended to enhance angler enjoyment or to increase protein production in the region. The scale of such transfers can range from the introduction of a species or genetic stock from a nearby location to the introduction of a species from a different continent.

These efforts often fail to recognize the complex genetic adaptation species have for their particular stream or lake. Native fish are adapted to survive in a particular location, while new stocks may come from a single genetic source that is often not suitable for the new habitat. Unfortunately, if the numbers are large enough, even introducing a poorly adapted stock may destroy a local population and result in the loss of genetic variability — another issue that is clearly recognized in the CBD. In some watersheds, all indigenous fish and fauna have disappeared over the last 50 years and have been replaced by species, such as the Chinese carps and several Tilapia species, that are already common around the world. These losses in biodiversity are permanent. We cannot re-invent the species that have become extinct nor can we be repaid for the potential economic or aesthetic value that the particular species might have imparted.

Sometimes species that have invaded new territory do not directly harm native species but do have indirect effects. Introduced species can carry diseases or parasites. For example, whirling disease, carried by trout stocked for sports fishing, is having a dramatic impact on western trout populations (Nehring, 1996a; Nehring, 1996b; Vincent, 1996)

Another indirect effect is the dilution or loss of native genetic diversity. Populations are often adapted to local conditions, but new species are sometimes so closely related to the local native species that they can interbreed. Interbreeding with introduced hatchery stocks or escapees from aquacultural operations may result in the loss of the genetic "fine tuning" that exists in the local stock. For instance we know that some introductions of rainbow trout have compromised the genetics of other western trout species (Goodman, 1990). This destroys our environmental heritage to the long-term detriment of future generations.



The sea lamprey is another species that has to be "controlled" in the Great Lakes. Increasingly, money spent on the *prevention* of exotic species would be money well spent.

Introduction of exotic species into North America is mirrored by depletion of the same fauna and flora in the native habitat of other countries. Often in developing countries, collecting specimens for sale to the public in the developed world is an important business upon which people depend for their survival. This collecting is carried out with little regard to conservation of the native ecosystem and, in the long run, to the local economy. Wherever the loss, it should be of concern to us all. We are all responsible for actions that reduce biodiversity around the world and should foster and support ecologically sustainable harvesting of wild stocks.

A WORLD MARKET: SOURCE OF EVER-INCREASING INVASIONS

Alien species ignore political and jurisdictional boundaries, and therefore, management must involve an inter-jurisdictional approach. As barriers to trade drop, there will be a steady and inevitable expansion in the number of species that accidentally enter the North American continent. They will come in various life stages (fertilized eggs, larvae, adults, spores, etc.), attached to packing, in boxes of fruit, in the bilge and ballast of boats, or in the luggage of tourists who have visited a foreign country. Some of these will not survive, but others will become established and threaten native fauna and flora.

The economic benefits of trade are an essential component of our future, but they will be diminished unless we become far more vigilant in preventing the introduction of species from outside North America. We must also guard against transfers of species between areas within the continent. (Witness the very common and uncontrollable dumping of bait in the northern US, which is introducing many fish and other freshwater species into Canadian watersheds.) Finally, we must become more knowledgeable, both about our native

fauna and flora *and* the species that have invaded our lands and waters.

NEED FOR A COORDINATED PLAN OF ACTION

To counteract the economic and biological damage caused by the both accidental and intentional introductions of new species, a number of steps need to be taken by North American societies:

- acknowledging that prevention is the key and funding preventive measures accordingly;
- increasing understanding and communication with rural and indigenous peoples;
- increasing accountability for any future introductions;
- developing a central database of information on introduced species;
- developing new scientific expertise; and
- encouraging governments to take a leadership role, including a strong educational component.

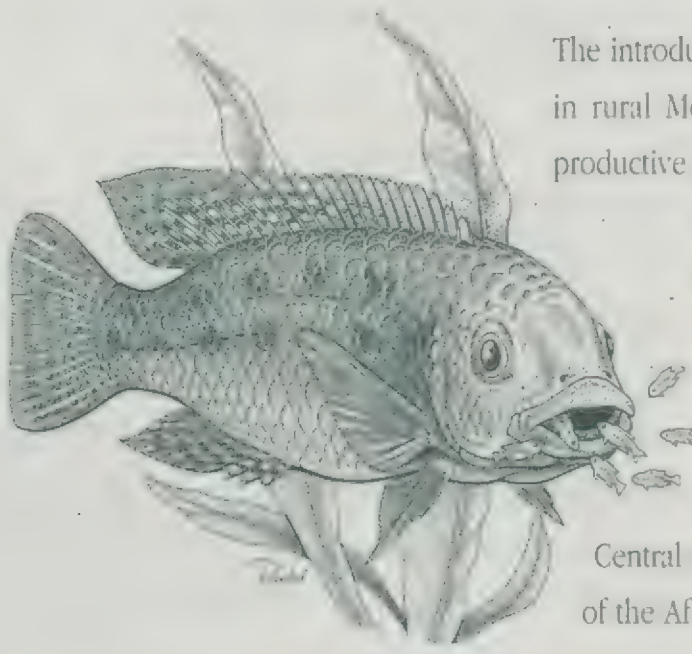
Prevention is the key

Once introduced and established, invasive alien species become self-sustaining and the vast majority must be regarded as impossible to eradicate. As mentioned, the cost of controlling a species is high. For instance, Fetterolf (1980) estimated the cost of controlling the sea lamprey in the Great Lakes between 1958 and 1980 at $54.5 million while in 1992, it cost $7 million dollars to spray for the Asian Gypsy Moth in Vancouver (Humble, pers. comm). There is also the cost of reducing the damage inflicted on natural biological systems or to the economic wealth of a nation. Not only are control techniques costly but often they achieve only limited results. They may also have a detrimental effect on native species. Therefore, it is imperative to place the emphasis on the *prevention* of introductions. In the past, governments have been reluctant to spend even a small percentage of the money they budget to "control" the effects of introduced species on basic prevention techniques, such as identifying and monitoring the distribution of the species.

Considering local needs and traditions

In Canada and the US the impact of alien fish species has been on biodiversity, habitat integrity, and sports angling. In Mexico, however, the impact on biodiversity and basic food production is far greater. Here, a number of species have been introduced with one of the best intentions in mind: food security.

When the need for food, especially in the form of protein, is addressed by the introduction of new fish to a region rather than by the enhancement of the production of native sources of food, problems arise. In certain situations the introduced species are beneficial, but in other situations, they can damage the natural environment and place native species at risk through competition, predation, or hybridization. Not only are introduced species often initially unacceptable as a food, they impose costly technological adjustments on the local people. For example, carp introductions in central Mexico forced people (especially those of ethnic origin, such as the Otomí) to switch from their traditional means of collecting and consuming crayfish, minnows, and amphibians to the initially expensive methods of collecting carp with large seine nets. All this for a fish that is less valued as food than crayfish. Because of the feeding habits of carp, the aquatic ecosystems became simpler (with crayfish becoming increasingly scarce), and, in order to have a sustainable carp fishery, fertilizers have



The introduction of Chinese carp and some Tilapia for food purposes in rural Mexico are good examples. Tilapia are known as highly productive species, easily managed, and cost effective, and therefore, this species perfectly suited the good intentions of aid efforts to introduce greater protein at low cost. No one bothered to examine the local alternatives because identification and knowledge of the ecology of local fauna was — and still is — poorly known. Despite this lack of knowledge, there are dozens of native cichlids in Central and South America that offer significant potential instead of the African Tilapia.

to be added, with the consequence that the ecosystems become increasingly eutrophicated. This is just an example of a system based on an alien species and illustrates that such systems are usually unstable and more expensive to manage than systems based on self-sustaining native species that provide predictable benefits to society. After all, the native species are usually free, are of high nutritional value, and are far more acceptable to people. Therefore, the potential for the aquaculture of native species should be considered before exotic species are introduced.

In general, governments do not pay enough attention to traditional customs or the needs and preferences of local people when considering a new plant or animal introduction, and thus, create social and economic problems as well as the obvious biological ones. Therefore, plans for such introductions should include a program of continuous communication with the local population and a strong educational component. Furthermore, special attention should be paid to the possibility that certain native species may play an important role in traditional customs and that they might be driven out by the alien introductions.

Increased accountability for planned introductions

Even with planned introductions there is a risk, and therefore it is essential that costs and benefits be carefully assessed before the introduction is made. In the case of commercial species, such a risk assessment should be made by the organization proposing the introduction. In addition, this organization or commercial group should take full responsibility and assume full liability for any damage resulting from the introduction. At present, there are no costs that can be legally applied if the introduction goes wrong.

Knowledge is the first step to management

At the moment, scientists are quite knowledgeable about a few of the alien species that occur on the continent but know little about the rest. While scientists may have an understanding of the species' ecology in its own habitat, they often have no appreciation of the interactions that may arise as a result of the introduction of said species into a new ecosystem.

Compounding this problem, none of the three countries in question has a central mechanism for recording and processing the data on species that have invaded the North American continent. In Canada, for example, an insect pest or plant is monitored to see whether it damages agricultural or forest crops, but not whether it attacks garden or wild species. Thus, the sudden expansion of the Lily Leaf Beetle (*Lilloceris lilii*) across north eastern North America from Montreal Island, where it had existed almost unoticed from its introduction in the early 1940s until the later 1970s, is of little interest to governments even though it is probably going to wipe out much of our lily (*Lilium*) stock in gardens and nurseries (LeSage, 1993). This species took 30 years to adapt to the local climate and the next adaptation is likely to be to a new host, the closely related endangered or threatened native lilies in our forests. To deal with such matters, it is essential to establish an integrated information system that would provide timely, reliable data about the presence, distribution, and status of alien species.

Ideally, such a centralized tracking system would be interactive and allow the public and decision-makers to access information and to report new information. At the same time, the system must also be able to accept and validate new records. In some cases, particularly in rural Mexico, a mechanism for transferring useful local information from the database to the local population, which usually lacks computer and modem equipment, must be established.

The need for timely and accessible information about alien species is essential for sound decision-making in the prevention, management, and control of these species. Advanced communications technology can be employed to aid in the rapid dissemination of this information. The Internet seems a logical place for such a centralized system that needs constant updating and revision. Workshop participants felt the system could be modelled on the successful American Web site that already contains useful information on invasive species <http://www.nfrcg.gov/fish/fishlist.htm>. As a start toward an inclusive, North American registry, Canada and Mexico could base their presentations of invasive species on the existing American model. Funding, of course, is required to do this.

Developing expertise

Another important part of the solution is the re-development of a cadre of scientists that can actually identify both indigenous and alien plants and animals. Why? Because the number of expert systematists has declined in recent years in all three countries. Due to funding cuts at government laboratories, universities, and museums, all of which provide employment for systematists, the remaining experts are reaching

retirement age and there are few young scientists entering the field as replacements. Before it is too late, we must encourage young scientists to take up the challenge of systematics work and we can do so by providing jobs. This is an essential part of the solution and not necessarily an expensive one. It is a small price to pay for a better understanding of our natural biodiversity and to help protect us from the pest and disease organisms that can cross our borders from every direction.

Leadership role for governments

Governments cannot do everything. There is clearly, however, a leadership role for the three national governments of Canada, Mexico, and the US in developing awareness, implementing protective measures, and maintaining a database that is available to everyone. Governments, too, have a role in developing international mechanisms to address invasive species issues and should ensure consultations take place between neighbouring states, provinces, or countries *before* introductions into shared water bodies or drainage basins are approved. Public education is also an integral part of any solution, and should encourage communication between the public, scientists, and governments. If ordinary citizens become more aware of the damage done by alien species, their knowledge will allow earlier detection and help reduce unwanted introductions by prevention

IN CONCLUSION

Alien species are a very important factor in the economic and ecological stability of Canada, Mexico, and the US. We urge the governments of these three countries to take action to work jointly to develop instruments to address the invasive alien species issues in North America. If we are to protect the long-term economic and environmental heritage of our children, better management of these species is essential.

ACKOWLEDGEMENTS

The authors thank the attendees at the Planning Workshop on North American Non-Indigenous Freshwater Fish Study, held in April 1996, for allowing the adaptation of their statement of concern. *From Mexico:* Dr. Patricia Almada-Villela, Dr. Salvador Contreras Balderas, Dr. Constantino Macías Garcia, Luis Zambrano. *From Canada:* Dr. Brian Coad, Mr. Alan Dextrase, Dr. Ian E. Efford. *From United States:* Amy J. Benson, Charles Boydstun, Dr. Larry R. Brown, Dr. Mark Coscarelli, Ann Foster, Pam Fuller, Dr. Hiram Li, Dr. Leo G. Nico, Dr. J.D. Williams. *Representing the Commission for Environmental Cooperation:* Dr. Andrew L. Hamilton.

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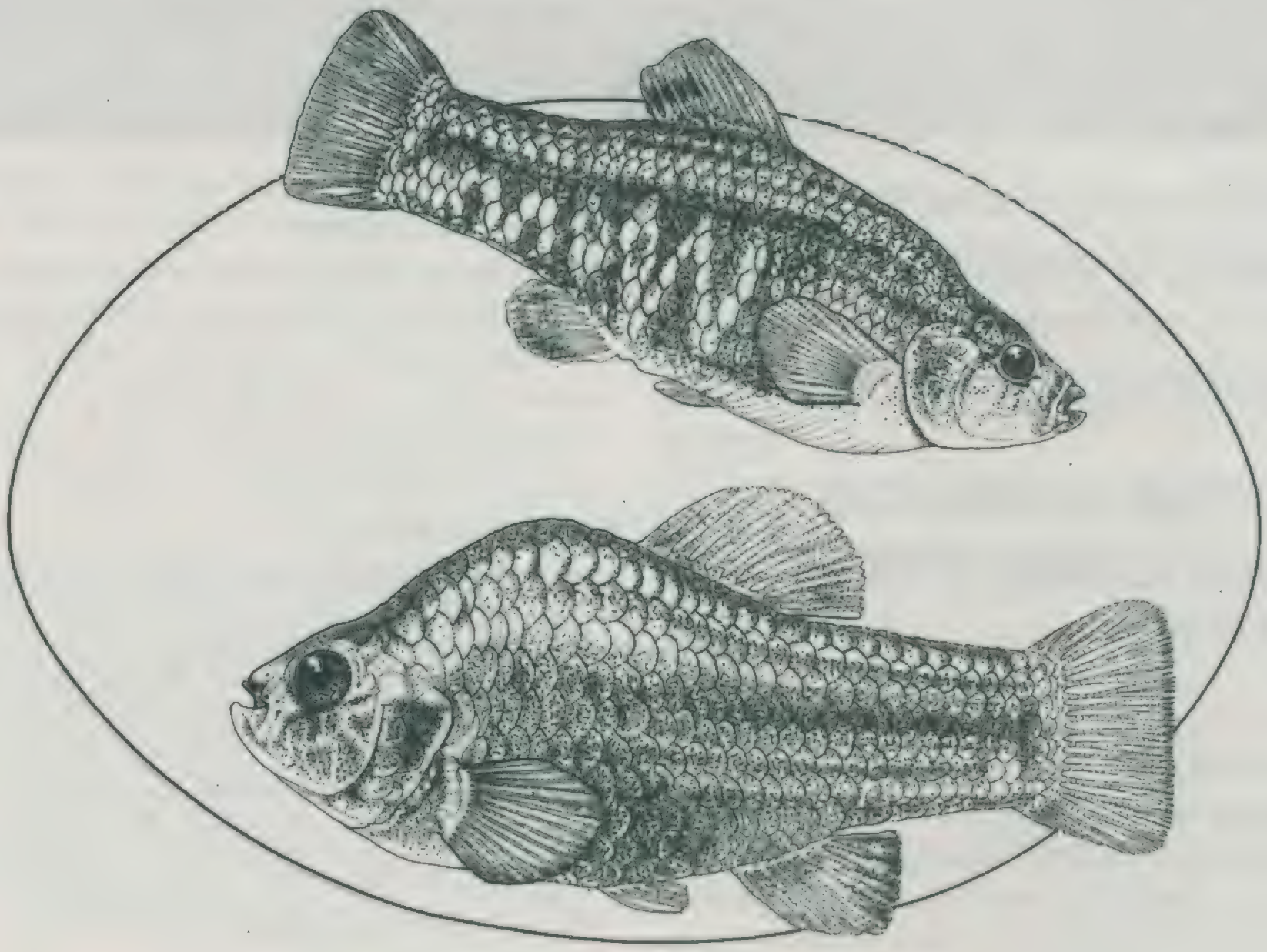
Desert Pupfish (*Cyprinodon macularius*)



The desert pupfish is only one species in a group of 20 species of small, oviparous fishes in the genus *Cyprinodon*, known as pupfishes. Fishes of this genus are highly adapted to desert conditions. Some species can tolerate temperatures up to 40°C and salinities to three times that of seawater. These adaptations have enabled members of the genus to thrive in the Sonoran Desert of southern California, southern Arizona, and northwestern Mexico.

Pupfishes generally are found in warm desert pools, marshes, streams, and springs and are resilient and adaptable fishes. *C. macularius* is a small (6 to 9 cm), silvery fish that matures within 2 to 3 months and lives for 6 to 9 months. Desert pupfish feed on small invertebrates as well as brown and green algae. During cold winter months, they become dormant and burrow into a muddy substrate.

The original range of *C. macularius* was the headwater area of the Colorado and lower watershed of the Gila rivers. It has been repeatedly relocated in conservation attempts so that it is now found in Salton Sea tributaries, Salt Creek in California, and in at least one Arizona spring. The species may also be found in the Colorado River, the Rio Sonora drainage and Santa Clara Slough in Sonora, Mexico. Habitat degradation and competition from exotic species have been the main threats to pupfishes. Water is a scarce enough resource in the desert, but the diversion of water bodies for direct human consumption and agriculture in the Sonoran Desert has caused the extinction of at least four species and six subspecies of fishes. Five species (including *C. macularius*) and two subspecies of pupfishes are currently listed as threatened. Current conservation measures include captive breeding, translocations to less threatened habitats, and protection of habitat.

Line drawing of the desert pupfish by Knud Skor. Prints are available, see page 41 for more information.

The looming threat to the fair sharing of benefits: What can be done to stop it?

Don E. McAllister
Editor, *Global biodiversity*

THE THREAT: SECURING ACCESS TO GENETIC RESOURCES WITHOUT SHARING THE BENEFITS

The International Biodiversity Convention was built on three cornerstones: conservation of biodiversity, sustainable use of its components and the fair and equitable sharing of benefits arising from the use of genetic resources. The fair and equitable sharing of benefits makes it worthwhile for developing countries, many rich in biodiversity, to conserve the diversity within their national boundaries. In return, the fair sharing of benefits also makes it worthwhile for developed countries to invest considerable resources and time into researching the potential products that biological resources have to offer us. In the end all of humanity benefits, and in essence, this part of the Convention is one of the most important, far-reaching global deals ever made.

Some corporations or transnationals in the North, however, seem to be seeking a way to evade the principal of fair and equitable sharing of benefits. In the North, pharmaceutical and biochemical corporations are buying up botanical gardens or access to them. The intent is to have access to all those genetic resources collected *before* the Biodiversity Convention came into effect. After all, if these genetic resources were obtained *prior* to the Convention, then there is no obligation to share the benefits, is there? As botanical gardens may contain up to 50% of all vascular plants species from around the world, this move threatens about half of the benefits that the South had hoped to gain from genetic resources.

Botanical gardens are not the only source of global genetic resources. Genetic material such as DNA and RNA can also be "recuperated" from museum specimens. Recuperation is simplest from dried specimens, possible from liquid preserved specimens, and with difficulty, from some fossil specimens. Most known species, and many unknown species, of plants and animals are represented in museum collections, the largest and most complete of which are located in the North. If corporations take the same approach to museum collections as they have taken with botanical gardens, then an even greater proportion of the benefits that the South had expected will be at risk. Certainly recourse would need to be made to the South for species represented by very poorly preserved specimens and for specimens of species not yet collected or described by science. Still this poses a major threat to the South and it can be expected to respond to defend its interests.

QUESTIONS FOR BOTANICAL GARDENS AND MUSEUMS

Botanical gardens and museums are currently in a difficult situation. Support has been declining for these institutions, especially for natural history museums and for the research in taxonomy that is carried out on natural history collections. At the same time the Convention and concerns about the environment have placed increasing demands upon collections and taxonomic research. Caught between these two conflicting pressures, there will be a temptation for such institutions to accept funding from corporations interested in access to genetic resources. Accepting such corporate funds will cause new problems, both ethical and real, for those institutions. Collecting specimens is generally carried out in other countries under a scientific permit. Such permits do not carry with them any right to exploit genetic resources, only to carry out taxonomic and evolutionary studies. Therefore the institutions that

now hold the collections derived from scientific research in other countries do not actually possess the right to sell genetic resources for commercial exploitation. Is this an area that is skated over by both corporations and institutions when working out a partnership?

Furthermore if institutions that possess collections were to make their specimens available for commercial genetic development, the South is sure to respond with measures unfavourable to scientific research. Within the limits of their budgets, most museums have an active collecting program in place so that they can complete their collections of certain taxa and obtain fresh material for research. If the South were to place restrictions on the collecting activity of these institutions, this would surely have an impact on taxonomic research. In turn, these new impediments to taxonomic studies will also be impediments to conservation, sustainable use, and new biotechnologies.

QUESTIONS FOR CORPORATIONS

Modern developments in pharmaceutical and biotechnological companies are dependent on solid, sound taxonomic research. Unfortunately for them, the world's taxonomic problems are far from settled. Between 90% and 99% of the world's species are still undiscovered, scientifically unnamed, and unclassified. And many named species still need to be properly positioned in a modern classification. If the South places restrictions on scientific collection expeditions, further research will be in jeopardy. Southern countries were, even before this new threat, already beginning to respond to concerns about the exploitation of their genetic resources. The new threat will assuredly accelerate legislation and regulation. Southern countries can be expected to react less favourably to those corporations that have evaded fair and equitable sharing of benefits from genetic resources. They may even compile and circulate lists of such corporations. Such corporations, which have attempted to gain short-term benefits by accessing Northern collections, may find themselves losers in the long term. They may even lose in the short term. Stock analysts may recommend lower values for stocks of corporations that have circumvented the intent of the Convention, and higher values for stocks of corporations that by their activities, will be more welcome in the South. It is clear that pharmaceutical and biotech corporations should carefully examine the ramifications of their policies in these areas.

QUESTIONS FOR GOVERNMENTS IN THE NORTH

States in the North should also examine their policies in regard to fair and equitable sharing of benefits. Few have made policy and legislative changes concerning this issue. Should states leave agreements about the fair sharing of benefits up to their national corporations and those corporations or states of the South? Or, should Northern states take into consideration the broad societal benefits that accrue from development of genetic resources and therefore involve themselves in the sharing process? What should be done about transnationals? Should they be treated by the Convention?

QUESTIONS FOR GOVERNMENTS IN THE SOUTH

The South, too, has decisions to make concerning access as well as biopiracy. If the South makes access to its genetic resources too complicated, it will be difficult to manage. It will also discourage development of new products and shared payments, royalties, production facilities, or capacity building. The South must also deal with how to share the benefits that are derived from the knowledge and specimens of the indigenous peoples. Indigenous peoples themselves are now, rightfully, considering their own position on these topics.

CONCLUSION

There are obviously many questions still to answer. It is my hope that botanical gardens, museums, corporations, governments in both the North and the South, and indigenous peoples can work together to ensure a true sharing of benefits for all concerned. Only by working together can humanity achieve the ultimate goal of a better life for all people at the same time as preserving and understanding the biodiversity that sustains this better life.

WHAT DO YOU THINK?

Send your opinion by mail, fax, or e-mail to the Managing Editor (see details on page 1). Or, visit the *Global biodiversity* Forum at <http://www.nature.ca/english/gbfor.htm> and add your views electronically.

Biodiversity reports

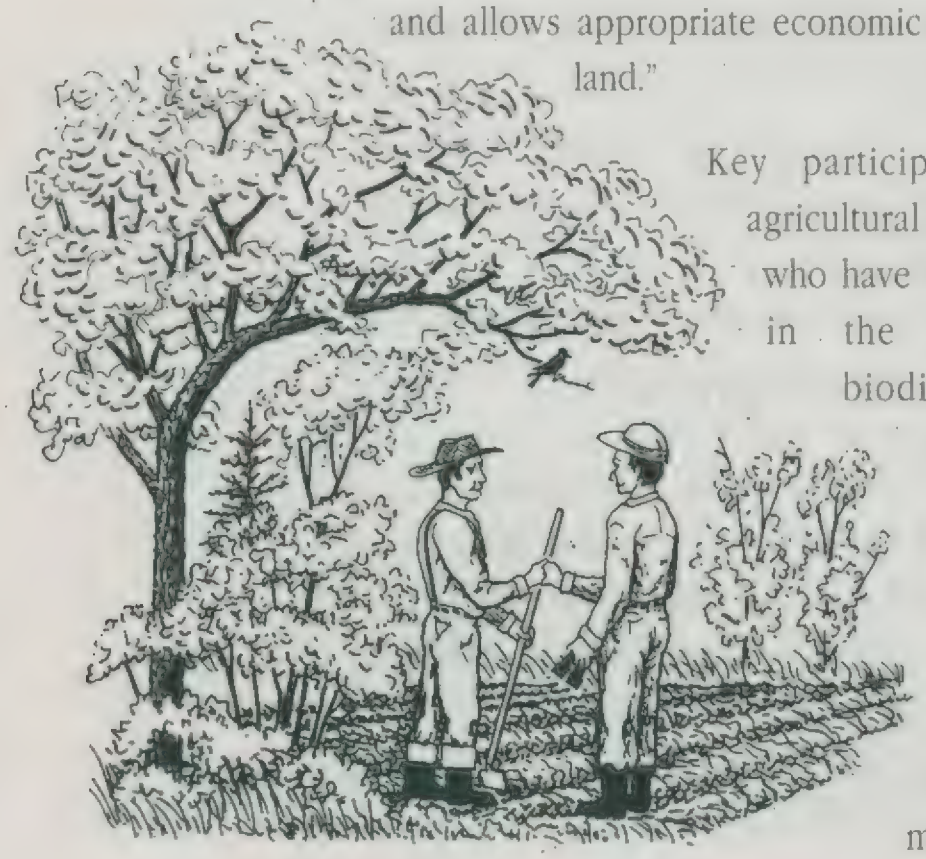
INCENTIVES FOR LANDOWNERS: GETTING FROM THE INTERNATIONAL AGENDA TO PLANNING LOCAL ACTION

Dateline: 23 February 1997
Ottawa, Ontario

Reporter: Cendrine Heumer, Canadian Coalition for Biodiversity

BACKGROUND

In Canada. the National Agriculture Environment Committee recognizes that all Canadians must share stewardship actions in order to achieve the goal of conservation and sustainable use of biological resources. It also wants to take advantage of the fact that farmers and ranchers in Canada are the largest landowners. Thus, in February it sponsored a multi-stakeholder workshop along with co-organizers: the Sierra Club of Canada, World Wildlife Fund, and Environment Canada. The mission of the workshop? To examine economic incentives that promote "Private land stewardship to protect and enhance biodiversity conservation in a way that supports the environmentally conscious landowner and allows appropriate economic activities on the land."



Key participants from the agricultural producer sector, who have been participating in the protection of biodiversity on their farms. their community, and region for years — both with and without incentives— attended the meeting. In addition, representatives from environmental non-government organizations, government representatives, environmental lawyers, and consultants participated. During this intense day, the 39 participants rolled up their sleeves and defined some possible solutions and priorities, as well as funding mechanisms.

QUESTIONS, SOLUTIONS, PRIORITIES

The first questions posed were of definition: What is public good? Who should pay to protect the public on private land? Should tax structure, mortgages, insurance, and loans be part of the picture? Do incentives and compensation go hand in hand? Is the removal of disincentives sufficient? And what biodiversity are we talking about?

It was recognized that positive steps have already been taken. Disincentives to donating land (for conservation purposes, for example) have been mostly removed, but incentives to do so have not yet been put in place. Ideas for incentives included a number of mechanisms and processes. Education (including a 1-800 number for a central information centre) was, of course, key. Building community capacity, and ensuring grassroots involvement combined with long-term strategizing for implementing a comprehensive plan were also priorities. To this end a newsletter tabloid or regular publication was envisaged. In addition, it will be important to make technical information available to agricultural producers, to identify success stories, and to use them as demonstrations of solutions. The formation of a task force. chaired by Sheila Forsyth. executive director of the National Environment Agriculture Committee, was roundly approved and several people have already volunteered to participate.

The task force will examine the feasibility of establishing a stewardship fund with, perhaps, matching funds and grants for compensation. Fines could be redirected from the Center for the Ecological Study of Perception and Action (CESPA) and disincentives, such as regional tax

formulations, could be removed, ensuring consistency in legislation. The task force would also look into a couple of difficult areas of discussion:

- how to equitably share the true cost of food production and how to address the prevalent low-cost policy;
- how to measure the value of the common good, particularly if compensation plays a role. The task force will also formulate principles to frame the distribution of the fund.

Further recommendations from participants included having biodiversity policies require Cabinet approval for long-term viability, and sensible linking between various policies such as CESPA, the North America Waterfowl Management Plan, the *Wild Animal and Plant Protection Act* and other biodiversity-related laws and policies.

To be effective, a good incentive:

- must be designed with long-term goals;
- must be fair to landowners and offer them the choice of participating in incentive programs;
- must complement the removal of disincentives;
- must differentiate between public good and private good;
- must be designed with an awareness of the broader issues; and
- must recognize fragile ecosystems.

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CONSULTATIVE MEETING ON CANADA'S SUSTAINABLE DEVELOPMENT STRATEGY (SDS)
Dateline: 17 February 1997
Ottawa, Ontario
Reporter: Don E. McAllister

SETTING THE STAGE

Canadian federal government departments are obliged to produce a strategy on their sustainable development (SD) by November 1997, and subsequently report on SD activities every three years. This report will be tabled before Parliament, reviewed by the new Commissioner for Sustainable Development and the Environment (who reports to the Auditor General) and made available for public comment and petition. Late in February, the International Institute for Sustainable Development (IISD) held workshops on a draft of this report, entitled Agenda 2000, which had been developed by the Department of Foreign Affairs and International Trade (DFAIT), largely internally. The workshops permitted public consultation, and after introductions to the consultations were given by John Fraser, Environmental Ambassador, and DFAIT and IISD staff, the attendees broke into five groups. For the remainder of the morning participants considered and commented on the more general introductory part of Agenda 2000, in the afternoon each working group considered one of five topics. Participants were asked *not* focus on consensus as DFAIT wanted to be aware of diversity of views.

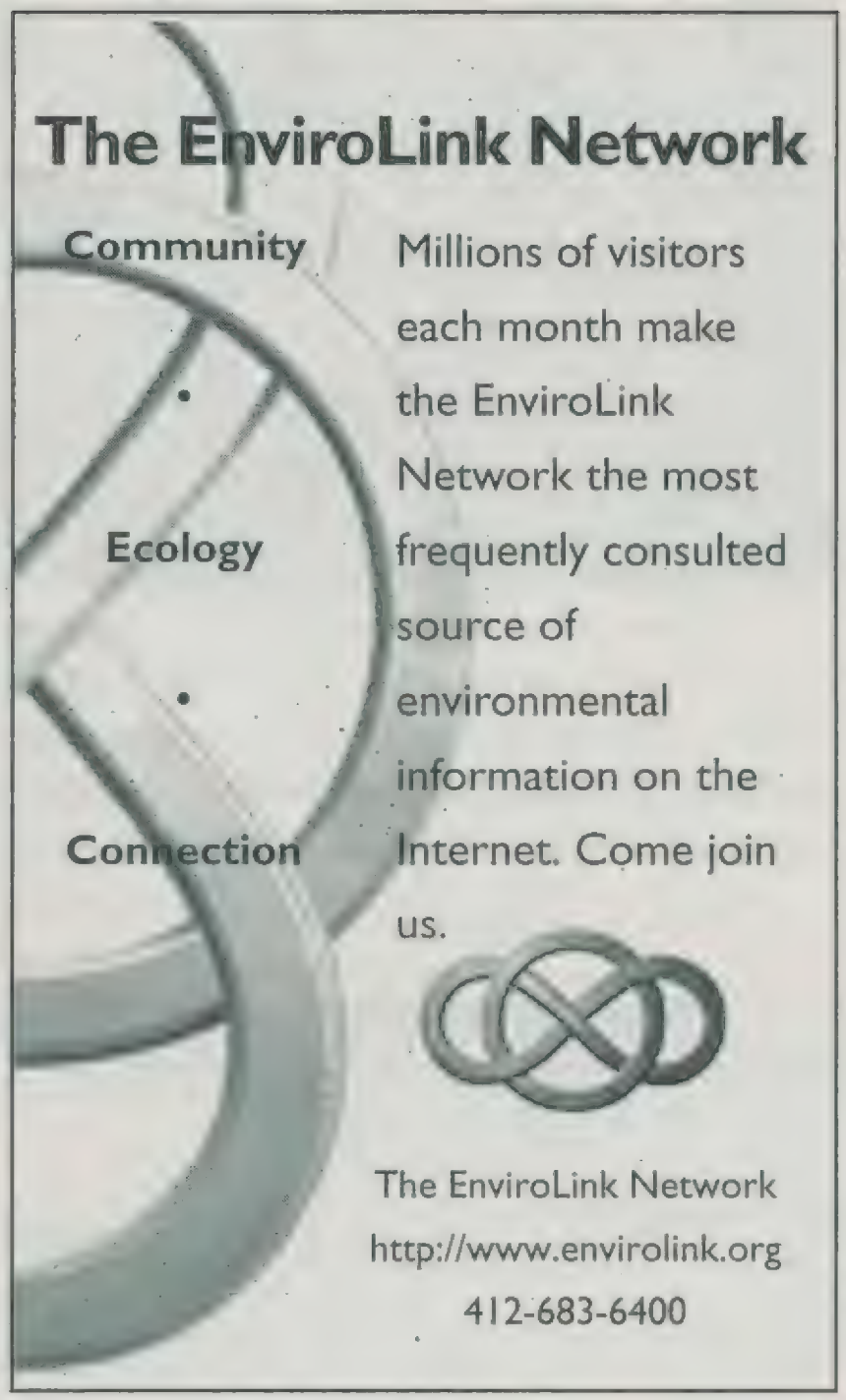
SUMMARY OF MORNING CONSULTATION

- There was a dualism between sustainable development being paramount, or economic growth and prosperity (the latter being the main focus of Agenda 2000). Growth and prosperity can conflict with social and environmental concerns. It was felt that Agenda 2000 presented, to some degree, the old classical economic model (free vs. fair trade) and downplayed social and environmental concerns.
- Attendees felt there was a strong need for consistency internationally and at home (i.e. we should practice what we preach overseas). The Canadian International Development Agency (CIDA) was having its own consultations; perhaps foreign policy and aid policy should be cohesive and the results of the two processes should be combined.

- There was a need to address diminishing levels of aid within the report.
- The report should better discuss awareness, education and training.
- DFAIT should rewrite the strategy in plain language with examples of success.
- Although Canada does have a leadership role to play, it should do so more by example than just brokering.
- Concerning Canadian values — we do have a strong pride in our connectedness to nature, our inclusiveness, etc. But projecting our values may be viewed insensitive — we can learn from a dialogue with our international partners.
- The report needs to bring concepts to the ground by accountability in government and civil society. Practice and actions count!
- The document needs to include greater emphasis on human well being.

Twenty-six government departments are developing SDS. We need an overall view and involvement of society as well.

The draft revised following the results of the Consultation will be distributed to the participants for their feedback. The resulting final Strategy will then be submitted through the formal process.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LOOK OUT FOR *GLOBAL BIODIVERSITY'S* FALL THEME ISSUE ON ECOFORESTRY.

The Guest Editor for this issue will be Herb Hammond, Director of the Silva Forest Foundation in British Columbia. The issue will include articles on practical strategies for communities and governments in transition to ecoforesty, indigenous forest use, impacts on wildlife, the making of an ecoforester, and alternative fibres. AND, coming in 1998, an ECO-AGRICULTURE theme issue.

Biodiversity news

New president appointed for the Canadian Museum of Nature

Joanne DiCosimo has been appointed as the new President of the Canadian Museum of Nature (CMN) and will take up her new position 1 July 1997. DiCosimo is currently Executive Director of the Manitoba Museum in Winnipeg (until recently called the Manitoba Museum of Man and Nature). According to Frank Ling, the Ottawa architect who chairs the Canadian Museum of Nature's board, DiCosimo was chosen because of her managerial skills and her 20 years of experience in museum management. While previous heads of the CMN have had doctoral degrees in biology, DiCosimo has an English degree from the University of Winnipeg and a Master's in public administration from Harvard. Ling states that her lack of scientific background won't be a problem because she has a reputation for delegating responsibility and relying on experts when it comes to scientific issues. DiCosimo is also known for her fund-raising abilities; the Manitoba Museum raised $7 million in recent years. This will be a valuable skill, given the recent government cuts to the budget of the Canadian Museum of Nature.

Canadian Museum of Nature celebrates new quarters

On the weekend of May 9th, Museum staff, colleagues, and friends attended the official opening of the Natural Heritage Building, at 1740 Pink Road, Aylmer, Quebec. This celebration is the end result of a major capital project that began in 1994 to bring most of the Museum's staff plus over 10 million natural history specimens into one location. The building of the new facility resolves the CMN's long-standing concerns about the inadequacy of previous collection facilities, most of which were never intended for collections in the first place, and about the inefficiencies of an operation spread over 13 different buildings in the National Capital Region. The Museum's public exhibits and galleries are still located in the Victoria Memorial Museum Building at the corners of Metcalfe and McLeod Streets in Ottawa.

Proposed change in emphasis in the Species 2000 program

An interesting development during 1996 was a proposed change in emphasis for the Species 2000 program that arose from participants' comments at the Manila meeting. The impetus for the program was and will continue to be to create a catalogue of all life on Earth. Links will now be made to the array of global species databases available, including flora/fauna/checklist databases, museum and herbarium accession databases, and germ plasm, garden, zoo, and culture collection databases. This secondary array of species databases allows many national and institutional data systems to participate in Species 2000. Thanks to Paul Smith, part-time project coordinator, progress locating and contacting databases has been remarkable. We are now in contact with some 70 databases.

Lois Blaine, David Gee, and Junko Shimura have been designing the first full version of the Common Access

Drawing by: Provencher Roy and Graham Murfitt.

System. The prototype version is now on the web at <http://www.sp2000.org> and linked to five databases — Bacteria (CHRONBACT), Corals (CoralBase), Fish (FishBase), Legumes (LegumeWeb), and Fossil Plants (Plant Fossil Record). In addition, Felipe Onoro has been preparing ways to determine user needs in developing countries; Michael Dadd is preparing both the hierarchy and the legal documents to register Species 2000; and Rainer Froese has been designing and preparing for the Annual Checklist.

Timetable and funding

The second project development grant proposal to the GEF was ready on 1 July 1996, as promised. However, because of ongoing debate about how the GEF would fund taxonomic projects linked to the Convention on Biological Diversity, the GEF Secretariat advised us to delay submitting our proposal until January 1997. If successful, the final project-preparation phase will run for six months, and will involve writing a new edition of the Central Access Software; working with Felipe Onoro to prepare a user-needs profile; proposing start-up sites in developing countries; and completing the proposal for the first phase of the main project. Along with funding applications to the GEF, we have been exploring other financial sources, including those in the US, Japan, European Union and the OECD (Organization for Economic Co-operation and Development) countries.

Much progress has been made in the quest to design and fund a program to index the world's species. The Species 2000 Federation was registered, formal membership was established, and the next major grant application was submitted early in 1997. [Condensed from the Species 2000 Chairman's Report 1996 by Frank Bisby, Chair: Species 2000 Project Management Team].

CWS turns 50

The Canadian Wildlife Service (CWS) was formed just after the Second World War ended, and in 1971 when Environment Canada was created, it became part of that department. CWS has much to celebrate — it has:

- established a network of protected areas for wildlife — over 11,000 million hectares!
- developed conservation policies and legislation, such as the recently introduced *Canada Endangered Species Protection Act*.
- conducted world-class research on migratory birds, polar bears, caribou, and the effects of toxic substances on wildlife.
- helped to establish the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), which prepares the official list of Canada's endangered species.
- restored waterfowl populations and habitat under the North American Waterfowl Management Plan with the United States and Mexico.

For more information, contact Pat Logan at (819) 953-1413.

National Dragonfly Museum in U.K.

There is a National Dragonfly Museum at Ashton Mill, Oundle, Northamptonshire, U.K. Information can be obtained by writing: The National Dragonfly Museum at Ashton Mill, Ashton Wold, Ashton, Nr Oundle, Northants, PE8 5LZ, Tel: 01832 272427. The museum is a registered charity (#1046086) in England. [Stuart M. Fullerton, ROF, Research Associate in charge of Arthropod Collections (UCFC), Biology Dept. University of Central Florida, Orlando, Florida, USA 32816. E-mail: <stuartf@pegasus.cc.ucf.edu>].

MABFauna/MABFlora available for distribution

The US Man and the Biosphere Program (MAB) has supported development of the standardization of biological inventory data that will facilitate the sharing of important scientific information among nature preserves. MABFauna and MABFlora are computer programs designed to allow users to input, edit, retrieve, and create checklists and reports of vertebrate and vascular plant inventories data. Both programs use master lists, but these are easily customized and allow input of new sites and species. This package also contains a module called "Observe," which can be used to catalogue sitings.

Both programs can be downloaded from <http://www.mabnetamericas.org> or <http://ice.ucdavis.edu>, or to obtain a free copy of MABFauna with manual (English and Spanish versions) and "Quick Start" (English, Russian, Spanish, Portuguese, French, and Bahasa versions) and/or MABFlora (English version only), contact U.S. MAB, OES/ETC/MAB, SA 44C, Department of State, Washington, DC 20522-4401, Tel: (202) 776-8318, Fax: (202) 776-8367, E-mail: <usmab@state.gov>.

Anyone interested in contributing species lists from their nature preserve or country-level species name databases, or adapting this software for other uses, please contact Dr. Jim Quinn, Tel: (916) 752-8027, Fax: (916) 752-3350, E-mail: <jfquinn@ucdavis.edu> or Dr. Brian

Bock, Tel: (202) 776-8315, Fax: (202) 776-8367, E-mail: <bbock@state.gov>. [Antoinette Condo]

Commitments to protect the North

In January 1997, World Wildlife Fund Canada (WWF) withdrew its Federal Court application for a judicial review of the recommendations that a federal environmental assessment panel made on the BHP diamond mine in the Northwest Territories (NWT). Why? Because the governments of Canada and the NWT have made some clear commitments to protecting the north:

- By 1998, the two governments will produce a Protected Areas Strategy, to be implemented by the year 2000.
- In the interim, in cooperation with aboriginal peoples and environmental groups, the two governments will provide interim protection of the highest priority sites. First Nations in NWT have already suggested candidate areas.
- The federal government has indicated that it is prepared to change federal environmental assessment procedures so that, in future, any project subject to the Act must take into account the impact of the project on *existing* protected areas and on the *opportunity to complete a network* of protected areas for the natural region in which the project is located.

[WWF News Release, 13 January 1997]

Greening DFO

The Canadian Department of Fisheries and Oceans (DFO) has embarked on a two-pronged national initiative to reduce the harmful impact of its operations ("Operational Greening Plan") and to bring its policies and practices into harmony with the principles of sustainable development. It will achieve the latter by presenting a Sustainable Development Strategy (SDS) to Parliament by December 1997. This strategy will be "complex and far-reaching...proposals are referred from virtually every industrial sector in Canada where projects would adversely affect fish habitat...a comprehensive approach will have to include the department's regulatory responsibilities [over fishing gear and catch levels], program delivery activities and in-house operations," said John Walsh, Chair of the National Committee leading the SDS development. The Operational Greening Plan will encompass every aspect of the department's work, from waste management, to procuring "green" products, to emergency spill response planning and clean up. [Adapted from *Pisces*, Oct./Nov. 1996]

Restoring the Bonaventure barachois

The Bonaventure barachois is a shallow body of water located at the mouth of the Bonaventure River in Quebec, which is partially cut off from the sea by a sand bar. The mixture of fresh and saltwater makes an ecologically rich area. Over the past century the barachois has been disturbed by human activities such as log drives, road construction, and wastewater discharges. In 1995 local residents founded the Association pour la revalorisation du barachois de Bonaventure (ARBB) and initiated a restoration project in conjunction with the Department of Fisheries and Oceans and the Quebec Department of Transportation. This project illustrates the way community groups can work effectively with government departments toward a common goal: preserving biodiversity. The project is one of many underway as part of the St. Lawrence Vision 2000 agreement, which is aimed at conserving, protecting, and restoring the St. Lawrence River ecosystem, and ultimately restoring the river so it can be used by the public. The ARBB will carry out environmental monitoring in conjunction with DFO. [Adapted from *Pisces*, Oct./Nov. 1996]

New paper for *Global biodiversity*

Starting with this issue, our paper is even more environmentally friendly! *Global biodiversity* is now printed on stock that is 100% post-consumer waste. It is made without the use of chlorine or chlorine compounds and without de-inking — the waste ink is incoporated back into the sheets. The paper is also pH neutral, and made in Canada.

Continuing yew saga

Canadian scientists in Edmonton, Alberta will test the effects of a powerful new drug treatment to combat breast cancer, based on natural chemicals from the European yew. Eventually the drug, docetaxel, will be tested on 1,600 women on four continents. Docetaxel, commercially known as Taxotere, is one of a group of chemicals known as taxoids. These are semi-synthetic drugs from needles of the yew tree. [*Ottawa Citizen*, 20 February 1997, page A3].

Yew branch

Cyberdiversity:

Biodiversity and the Internet

Clickable identification key to the vascular plant genus *Miconia*

The Base de Dados Tropical (BDT) of Brazil has just launched information about the species *Miconia*, which occurs in the Brazilian state of Sao Paulo. The information was collected by researchers from the Biology Department of the State University of Campinas (UNICAMP) and from the Bioscience Department of the State University of Sao Paulo (USP). The 53 species listed and described represent all taxa of the genus expected to occur in this state. A "clickable" identification key is also included, with pictures and figures of species and determinant characteristics. All information is available at: <http://www.bdt.org.br/bdt/miconia/>, or contact Marinez Ferreira de Siqueira, Fundação Tropical de Pesquisas e Tecnologia "André Tosello," Base de Dados Tropical, Rua Latino Coelho, 1301 - Parque Taquaral, 13087-010 - Campinas - SP – Brasil, Tel: 55 19 2427022, Fax: 55 19 2427827, E-mail: <marinez@bdt.org.br>.

Web resources on endangered species

A year ago the US Fish and Wildlife Service's (FWS) Division of Endangered Species launched a new web site to offer users a more comprehensive look at threatened and endangered species. There are four main categories on the site: Program, Species, What's New? and Frequently Asked Questions. For ease of use on the Web, species lists are broken into five index sublists: vertebrate animals, invertebrates, flowering plants, non-flowering plants, and all foreign listed species. A separate species profile is available for each species in the list. Go to <http://www.fws.gov/~r9endspp/endspp.html>. [*Endangered Species Bulletin*, Vol. XXI, No. 1, Jan/Feb 1996]

Participate in the International Year of the Reef

Ten percent of the world's reefs have already been seriously degraded and a much greater percentage is threatened. Over 50 organizations are already involved in the International Year of the Reef (IYOR), helping to support coral reef research and conservation efforts worldwide. To find out more about the IYOR and how you can get involved, visit <http://www.coral.org/IYOR/>.

Arctic Odyssey

Discover Arctic science and nature in this virtual rendition of the new Canadian Museum exhibit that opened in June 1997, in Ottawa, Canada. Especially good for educational purposes. Web-site: <www.nature.ca/english/arctic.htm>.

Biodiversity meetings

10–12 SEPTEMBER 1997

Entomology '97, to be held in Newcastle, U.K.

Contact: *The Registrar, Royal Entomological Society, 41 Queen's Gate, London, U.K. SW1 5HR. E-mail: <reg@royensoc.demon.co.uk>*

12–14 SEPTEMBER, 1997

Biotic Recoveries from Mass Extinctions, to be held in Prague, Czech Republic.

Contact: *Petra Hovorkova, Recoveries '97, Eurocongress Centre, Budejovicka 15, CZ 14000, Praha 4, Czech Republic, E-mail: <recovery@gli.cas.cz>, Web site: <http://www.gli.cas.cz/conf/>*

21–23 SEPTEMBER 1997

1997 Forum on Wildlife Telemetry, to be held in Snowmass, North Dakota, USA.

Contact: *Jane Austin, Northern Prairie Science Centre, 8711 37th Street SE, Jamestown, ND, USA. 58401. E-mail: <jane_austin@nbs.gov>*

13–22 OCTOBER 1997

XI World Forestry Congress, to be held in Antalya, Turkey.

Contact:. *Mesut Y. Kamiloglu, Secretary-General, OGM Gazi Tesisleri, 1 No'lu Bina, Kongre Salonu, 06560 Gazi, Turkey, Tel: 90-312-212-4965, Fax: 90-312-212-8482, E-mail: <obdi-f@servis.net.tr>, Web site: <http://www.fao.org/waicent/faoinfo/forestry/wforcong>*

6–10 NOVEMBER 1997

Forum Planèt'ERE, the first international francophone forum on environmental education and training for sustainable development, to be held in Montreal, Quebec.

Contact: *Forum Planèt'ERE, Centrale de l'enseignement du Québec, 9045, rue Sherbrooke Est, Montreal, Quebec H1L 6P3, Tel: (514) 356-8888 ext. 2112, Fax: (514) 356-9999, E-mail: <planète.ere@ceq.qc.ca>, Web site: <http://ceq.qc.ca>*

9–12 NOVEMBER 1997

ISTA IV — 4th International Symposium on Tilapia in Aquaculture, to be held in Orlando, Florida, USA.

Contact: *Kevin Fitsimmons, ISTA IV, University of Arizona, 2601 Airport Drive, Tucson, Arizona, USA 85706, Tel: (520) 741-1990*

14–15 NOVEMBER 1997

Future Priorities for the Conservation of Mammalian Biodiversity: Flora & Flora International / Mammal Society Symposium, to be held in London, UK.

Contact: *Dr. Abigail Entwistle, FFI, Great Eastern House, Tenison Rd., Cambridge, UK CB1 2DT*

25–27 NOVEMBER 1997

2nd Workshop on Limnology and Waterfowl of the Working Group on Aquatic Birds of the International Limnological Society, to be held in Celestún, Yucatán, Mexico.

Contact: *Joseph Kerkes, Canadian Wildlife Service, 5th Floor, Queen Square, 45 Alderney Dr., Dartmouth, Nova Scotia B2Y 2N6, Tel: (902) 426-6356, Fax: (902) 426-4457, E-mail: <KerkesJ@NS.doe.ca>*

16–20 FEBRUARY 1998

Medicinal Plants for Survival — An International Conference on Medicinal Plants, to be held in Bangalore, India.

Contact: *Foundation for Revitalization of Local Health Traditions (FRLHT), No. 50, 2nd Stage, MSH Layout, Anandnagar, Bangalore 560024, India, Tel: 91 80 333 6909/0348, Fax: 91 80 333 4167, E-mail: <root@frlht.ernet.in>*

22–23 APRIL 1998

SupraDarwinian Modes of Evolution, to be held in London, UK.

Contact: *The Science Promotion Section, The Royal Society, 6 Carleton House, Terrace, London, UK SW1Y 5AG, Web site: <http://britac3.britac.ac.uk/rs/>*

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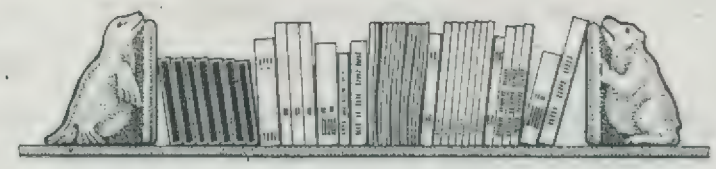
Ocean Voice International, an NGO, works to conserve marine biodiversity and foster sustainable harvest of resources through education, research and partnerships. Members receive a quarterly bulletin, *Sea Wind* — Individuals $25/year, Institutions, $50/year. Address: PO Box 37026, Ottawa ON K1V 0W0, Canada, URL: <http://www.ovi.ca>.

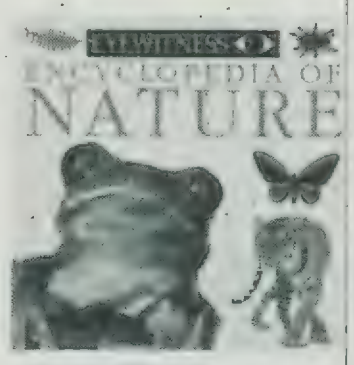
Desert pupfish Prints of the desert pupfish appearing on page 31 of this issue are available from Linn-Tarn, Box 20600, Perth Mews Postal Outlet, Perth, ON K7H 3M6, Canada. Prints are blue and black printing on mauve hand-made paper, 9.75 x 8.5 inches (25 x 21 cm). Price: $25 postpaid, two for $40 (orders from outside Canada, please pay in US dollars).



Book and periodical niche

Eyewitness encyclopedia of nature CD-ROM

1995. Dorling Kindersley Multimedia. 95 Madison Avenue, New York, NY, 10016. In Canada: General Publishing, 30 Lesmill Rd., Don Mills, ON, M3B 2T6. ISBN (Windows) 0-7894-0041 (Macintosh) 0-7894-00952. $49.95.



If you're at all familiar with the Eyewitness series of books, you will feel right at home with the *Eyewitness Encyclopedia of Nature* CD-ROM. The producer, Dorling Kindersley Multimedia, has managed to translate the crisp, clean style of the books into a crisp, clean, seamless CD-ROM. It is pleasing to the eye, packed with lots of useful information, and packaged in a format that is inviting and non-threatening to first-time multimedia users.

The main screen of the *Encyclopedia of Nature* is a clever representation of a naturalist's office, complete with specimen drawers, a globe, barometer, microscope, books, and posters on the wall. By opening drawers, spinning the globe, or clicking on the wall posters, the user is effortlessly transported through the various layers of information on the disk.

And there is enough information to keep users busy for hours! The CD-ROM offers solid, basic information on all the major animal and plant groups and selected species — plus, sections on habitat (beautiful panoramas with hot spots), microscopic life, prehistoric life, and climate. There is also a Quiz Master, so players can test their knowledge of nature facts. It must be noted that the CD is geared to an average child and parent; serious naturalists will find the information too superficial.

The text is accompanied by sharp photos and illustrations (including anatomical views), clear audio, good-sized video clips, and some clever animated sequences (for example, a rattlesnake injecting venom into its victims). What all this adds up to is a well-produced, entertaining CD-ROM that manages to also be educational. The *Eyewitness Encyclopedia of Nature* deserves a prime spot in your multimedia library.

Lorna Sierolawski, Audio-Visual Officer, Canadian Museum of Nature

Biodiversity loss, economic and ecological issues

Edited by Charles Perrings, Karl-Göran Mäler, Carl Folke, C.S. Holling, Bengt-Owe Jansson. 1995. Cambridge University Press. ISBN 0-521-47178-8. 332 pp. £35.00.

The economics and ecology of biodiversity decline, the forces driving global change

Edited by Timothy M. Swanson. 1995. Cambridge University Press. ISBN 0-521-48230-5162. Hardcover. US $39.95.

In two European workshops held in 1995, biodiversity was considered from the differing perspectives of economics and ecology. A volume was prepared on each workshop, each of which presents a series of papers on biodiversity and its decline written by workshop participants — internationally known commentators with expertise in either economics or ecology. These are two excellent books that examine the causes and consequences of biodiversity decline.

The shorter of the two — *The Economics and Ecology of Biodiversity Decline* — is presented in four sections and thirteen chapters. The introductory chapter gives an overview of the perspectives contained in each of the sections and, in fact, provides a much-needed thread linking the articles with the sectional topic. Each section

focuses on a reason behind the decline of biodiversity: choice of development path; institutional failure; policy failure; or consequence of development. Three articles address each of these reasons.

The articles are generally stand-alone pieces that, were it not for the introductory chapter, would have been difficult to classify. A couple of papers are mathematical wizardry exhibitions (e.g. Hartwick); others are well written, reasoned, balanced views on biodiversity decline (e.g. Myers); and still others are somewhat vitriolic in their view of economics and economists (e.g. Roughgarden). Some articles relate to biodiversity dynamics and decline in specific geographic areas while others are more generic — a good cross-section of views. Overall, the book makes a useful contribution to the literature on biodiversity and the causes of its decline. It is well organized and exhibits the fundamental characteristic of biodiversity: diversity of opinion.

The second workshop report — *Biodiversity Loss, Economic and Ecological Issues* — is also an excellent book with a wide range of ideas and arguments concerning biodiversity decline. There are four sections to this book: conceptualizing diversity and ecosystem functions; integrating ecology and economics in the analysis of biodiversity loss; economic issues; and conclusions.

The introductory chapter is an excellent guide to the volume and provides much needed background information, especially relating to ecological issues, that assists the reader in understanding concepts such as ecosystem resilience, ecosystem behaviour, and ecological functions. This introductory chapter also provides the links between the different chapters and papers in a logical and useful manner.

Similar to *The Economics and Ecology of Biodiversity Decline*, it contains several articles that are highly mathematical and/or graphically obtuse, but the majority of chapters are geared more to the general reader. A range of topics and perspectives are discussed. Chapter titles include: Diversity Functions; Wetland Valuation: Three Case Studies; Economic Growth and the Environment; and On Biodiversity Conservation. The final chapter, Unanswered Questions, provides a good summary of the issues and concerns that remain on both the ecological and economic front concerning biodiversity conservation and loss.

Neither work resolves the issues of or presents solutions to the problem of biodiversity loss. But greater understanding of the problem and its root causes emerges, plus an appreciation of differing views on why biodiversity loss occurs. Both volumes provide a good integration of ecological and economic perspectives and issues concerning the causes and consequences of biodiversity loss. While some of the technical economic calculations could be daunting to some readers, these two volumes provide such a variety of useful viewpoints that they are both recommended reading.

Peter Whiting, Managing Partner, The Outspan Group, Amherst Island

Okoboji wetlands: A lesson in natural history

By Michael J. Lannoo. 1996. University of Iowa Press, Iowa City. 156 pp. Paper. ISBN 0-87745-532-5, US $14.95.

Although unabashedly written for those who know the Okoboji lakes region, this book will nonetheless be of interest to many others. Its stated goal is to bring the biodiversity crisis home, and it does so by describing changes that have occurred in the natural wildlife of the Okoboji lakes in the Iowa Great Lakes region.

The book begins by describing wetlands in general, then describes the Okoboji region, its ecosystems, its historical fauna, its present day fauna, and past and present management practices. The final chapters evaluate these practices and suggest a new system of evaluation where the value of future diversity would be weighed against immediate gain. Each chapter is a series of essays, some written by the author, others written as long ago as 1906. These older essays are particularly interesting as they describe scenes undreamt of today. There are archival photos, colour plates, and numerous line drawings, as well as an ongoing description of the history and the mandate of the Iowa Lakeside Laboratory, at which the author is a member of the faculty. The latter narrative is rather tangential but laudable since proceeds from book sales go to the facility.

The emphasis in the book is on animals, especially amphibians. Although a basic knowledge of wetland wildife is not needed, some familiarity will enhance appreciation of the species' descriptions given. Written for the layperson, discussions of topics such as the differences between lakes and wetlands, the causes of

summer and winter kills, and the consequences of exotic species introductions, are clear, simple, and sound. But, regardless of who reads the book, in profiling the Okoboji wetlands area, the author provides a glimpse into the past, the present, and possibly the future of not only Okoboji, but of other wetlands as well.

Irene C. Wisheu, Department of Biology, McGill University, Montreal, Quebec

Ecology and Conservation of Amphibians

T. J. C. Beebee. 1996. Chapman & Hall, London, U.K. 214 pp. Hardcover. ISBN 0 412 024109.

Adding amphibians early (Number 7) to this continuing series on the challenges of world conservation research is fitting. At 4000 species (about 8% of living vertebrates) amphibians are, Beebee argues in his preface, "ideal subjects for many kinds of ecological studies that can throw new light on fundamental questions in the natural sciences, and at the same time they exemplify the plight of wild creatures suffering declines all over the planet at human hands." The following ten sections justify these declarations.

The section "What are amphibians," defines the Class, and contrasts frogs (which have 1500 species in Central and South America, 80 in North America, 25 in Europe, 880 in Africa, 650 in Asia, 250 in Australia) with salamanders (130, 150, 25, <5, 60, and 0 species on the same continents), and caecilians (70, 0, 0, 30, 40, and 0). "Why study amphibians," discusses their broad value to the field of biology, particularly the early work in embryology and development, later in ecology and speciation, and most recently as harbingers of doom, their diminishing numbers is a possible early warning of the global environmental deterioration that could increasingly become evident in other species. "Evolution and phylogeny" emphasizes the relevance of amphibians to ecology and evolution, the question of hybrids and what a species is. Beebee cautions (page 59) that it is "important not to 'create' new species on flimsy morphological grounds, without checking by molecular and/or genetic means that they really are distinct," but regrettably makes no similar caution against the erection of species on flimsy molecular grounds.

Sections 4 to 6 focus on particular aspects of ecology: "Behavioural" covers migration, sexual selection, and kin selection studies; "Population" details some generalized features of amphibian populations, methods employed in their study, population dynamics and genetics, metapopulations, and the colonization of new habitat patches; and "Community" returns us to the importance of amphibians place in the overall ecosystem.

The concluding four sections begin with "Distribution, abundance and extinction risk." "Threats to amphibians" documents habitat destruction and alteration, agrochemicals, atmospheric pollution and direct human killing and "How to conserve amphibians" covers general strategies, laws, site acquisition, applied research, habitat management and creation, captive breeding, and translocation. "Amphibian conservation in action" discusses very rare species, widespread but local (specialist) species and widespread generalist species, and concludes with an overview.

There are 8 tables and 48 figures (species and habitat photographs, diagrams, and graphs). Although often inferior in reproduction quality, they still effectively illustrate the text. The book ends with a 21-page reference section, a 4-page section providing English and scientific names, and an 8-page topic index.

Beebee's own research has focused on the six amphibians in Great Britain, including early work on the Great Crested Newt (1975), a definitive volume on the Natterjack Toad, *Bufo clamata* (1983), and commentary on habitats, declines, and conservation. Here he blends this background with his broad grasp of the current literature to produce an effective reference source. The future he predicts is challenging but stimulating; there are many gaps in knowledge still to be filled, and promising conservation strategies still to be fully tested. The study of amphibians will continue to contribute to this future.

Francis R. Cook, North Augusta, Ontario

Darwin's dreampond: Drama in Lake Victoria

By Tijs Goldschmidt. 1996. Translated by Sherry Marx-MacDonald. MIT Press, Cambridge, Massachusetts. 274 pp. Hardcover, ISBN 0-07178-9. US $25.00

In this book, Goldschmidt gives observations from his scientific study on species-flock evolution and eventual extinction, as well as recollections of his years spent researching the "furu," cichlids of the genus *Haplochromis*, in Mwanza Bay of Lake Victoria. Although the author sometimes questions his own motives and purposes for his research, he in fact reveals interesting

aspects of species-flock evolution and, unfortunately, of the eventual extinction. Goldschmidt spent his years in Tanzania during the time when the cichlids became affected by the introduction of Nile perch into Lake Victoria. The many new species found by the author and his colleagues eventually disappeared from their study sites.

In a few places, this book does not flow well; some passages leave the reader behind as the author switches to a new locale or time without warning. Overall, however, it is a well-balanced blend of scientific information and the author's observations about life among the Sukuma people in Tanzania. The humorous, but somewhat unflattering, depictions of molecular biologists (p. 47) and the role of a taxonomist (p. 26), are counterbalanced by Goldschmidt's sympathetic descriptions of the contrast between European and African culture. The clash between the Sukuma and "mzungu" (politely translated by the author as "wanderer") concepts of time is only one of the differences that causes frustrations for the foreigner.

Goldschmidt gives cogent explanations of scientific methods and principles, that clarify the reasons for studies such as his. The author (and translator) have succeeded in presenting some difficult concepts in a way that a reader with little scientific background will have no trouble understanding. This is of great value in a field where lack of understanding often leads to lack of funding.

A few errors occur in the book (e.g. p. 25 "like most fish, it has only a single nostril" and p. 231, *"Salvelinus namac"* instead of *Salvelinus namaycush*) but these are probably the result of translation and editing. The only things lacking in this book are useful illustrations. Unfortunately, the few illustrations that are present did not reproduce well. I would have preferred different illustrations than those given, such as pictures of the teeth of the fish, rather than pictures of the fish's prey. References that are cited throughout the book are listed in eleven pages at the end, along with a glossary and index. Overall, the book is a "good read," suitable for a wide audience with or without a scientific background.

Alison Murray, Research, Canadian Museum of Nature

Environmental impact assessment

2nd ed. By M. Husain Sadar. 1996. Carleton University Press Inc. for the Impact Assessment Centre, Carleton University, Ottawa. Softcover. 191 pp. ISBN 0-88629-300-6. $24.95.

Even a cursory glance will leave no doubt in the reader's mind as to the purpose of this publication. This well laid-out, illustrated training manual presents the subject of environmental impact assessment (EIA) in an orderly and concisely written manner. This approach is in keeping with the needs of the subject matter and with the methodical nature of the process of preparing EIAs as described within the eleven chapters.

The chapters proceed stepwise through various introductory sections and then cover the essentials of the EIA process with topics such as: key elements of an EIA; tools and techniques; the scoping procedure; prediction of impacts; evaluating impact significance; mitigation, compensation, monitoring, and follow-up. An additional chapter deals with issues on making recommendations to decision-makers. These eight chapters comprise the core elements of the EIA process. They are clearly presented, with the primary points emphasized in bulleted lists, and complemented by the ample use of examples of tables, charts and matrices. Each of these first eight chapters is summarized in full page, 3-D example boxes that can be converted into overhead transparencies. Chapters on emerging issues in EIA, priority areas for EIA research, and training needs for developing countries round out this primer on EIA. Recommendations are provided for further reading. A glossary of terms, five case study exercises and a sample course evaluation form make up the three appendices.

The author places the manual clearly within a Canadian context, through references to the evolution of Canadian federal and provincial legislative requirements for EIAs. Three of the case studies outlined are within provincial settings. This is a logical framework in view of the origin of the publication — a centre at a Canadian University where EIA is taught. However, the actual information and process for developing EIAs are clearly generic and global in application. Similarly, the five case examples provided as student projects have broad applicability, even though several are placed within Canadian landscapes. These case studies range from a simple proposal to develop a nature trail to considerably more complex projects involving marine dredging,

development of an irrigation system; uranium mining, and hydro-electric power generation with international implications.

This training manual updates and expands a publication that has been widely used and translated into several languages. It provides the basic structure for establishing a course on EIA and allows students to readily grasp the essentials of the process and to apply the principles to case studies. For consultants and officials involved in EIAs, it also serves as a valuable review and reference source.

Erich Haber, Consultant, National Botanical Services, Ottawa

The idea of biodiversity: Philosophies of paradise

By David Takacs. 1996. Johns Hopkins University Press. Hardcover. 393 pp. ISBN 0-8018-5400-8. US $35.95.

This is a "meta" book, focusing not on issues in biodiversity and biological conservation *per se*, but on the movers of these activities, their frameworks, and the scientific and social consequences of their efforts. The "Philosophies of Paradise" are only those stemming from biodiversity, not from religions heralding Future Worlds or economics anticipating the entire surface of the Earth covered a thousand storeys deep with humans. And it is a very personal account, as Takacs makes clear in his Preface. He recounts his motivation for the volume in terms of his distress, as a graduate student, with Cornell's administrative structure (certainly not my experience in the same capacity) and his contrasting elation on hearing Dan Janzen. This experience led to interviews with some two dozen leading figures (such as Paul Ehrlich, Tom Lovejoy, and Peter Raven) that serve as the basis for the book. Also from the outset Takacs emphasizes his intention to challenge the value-neutrality of science.

An opening conceptual analysis of "nature" and "biodiversity" reveals Takacs' passionate interest in these subjects. Then there is a useful history of approaches to biology and conservation reviews in particular the contributions of Aldo Leopold, Charles Elton, Rachel Carson, and David Ehrenfeld, and the pivotal 1986 conference in Washington in which "biodiversity" emerged as "biological diversity" minus the "logic." This term is then well scrutinized in terms of its relations to similar biological terms and to cultural diversity, to conservation laws and their objectives, and to the political context. Takacs also considers more philosophical issues, including holism versus reductionism and links to "deep ecology" in which values are extracted from the science.

Takacs then jointly and at length examines environmental history (how humans have viewed themselves within nature) and science studies (analyses of the psychology and sociology of scientists and their institutions). He explores the activities of leaders in terms of training, intellectual contributions, values, communications, and political activities, with emphasis on boundaries between these roles and their social constructions. Certainly the broadened role of such scientists is seen in many institutions, including the Canadian Museum of Nature. While the author draws well on the relevant literature and presents much good analysis, he plays fast and loose in challenging the fact/value distinction in an intellectually irksome and unconvincing fashion. In this regard it is noteworthy (and naughtily amusing) that Takacs is annoyed by the benighted positivism prevalent in those whom he acknowledges as leaders in the field.

The subsequent presentation of the potential values of biodiversity is also lengthy but more satisfying, with a good discussion from utilitarian and aesthetic viewpoints. The attention to the political dimension is especially appropriate. Two biographies follow, one institutional (Costa Rica's INBio) and one personal (E.O. Wilson). The account of INBio is balanced in terms of achievements and risks of this exemplar of "science in action." The evaluation of Wilson recognizes his enormous contributions, but is marred with querulous complaints that, for instance, Wilson has avoided hard questions and answers. In his conclusion Takacs correctly draws attention to the personal, social, and political contexts of biodiversity and science, and the need to sort through claims critically. Alas, he also emphasizes the value-ladeness of science, a currently popular theme but one which many of us think is fallacious, which results from a lack of just the criticality which Takacs calls for.

At several points in the discussion the responses of the interviewees to the same question are presented alphabetically in transcript. This inclusion certainly permits comparisons, but it is lengthy and raw material. Notes, references, and an index supplement the text. Overall, readers will find this an interesting, if somewhat irksome, book.

Patrick Colgan, Book Review Editor, Global biodiversity

Our Living Resources: A Report to the Nation on the Distribution, Abundance, and Health of U.S. Plants, Animals, and Ecosystems

Edited by E.T. LaRoe, G.S. Farris, C.E. Puckett, P.D. Doran & M.J. Mac. 1996. U.S. Department of the Interior National Biological Service, Washington, DC. 530 pp.

The point that the appropriate management and use of any resource requires inventorying and monitoring has been made so often that it is now a truism. This substantial publication is thus a significant step for the United States in developing sustainable use of its biological resources. Despite being a signatory to the Convention on Biological Diversity without ratification, this publication certainly fulfils some of the obligations required by certain articles of the Convention.

"Part 1: Introduction" briefly discusses the importance of knowledge of biodiversity and conservation, and stresses the value of long-term data sets in order to assess status and trends. "Part 2: Distribution, Abundance and Health" covers taxonomic groups such as birds, mammals, reptiles and amphibians, fishes, invertebrates, and plants. Each section begins with an overview and follows with specific groups and special issues for the taxon. It also covers ecosystems: terrestrial, freshwater, riparian, and coastal and marine. Short sections on ecoregions such as the Great Plains, the Interior West and Alaska provide a discussion of ecosystem diversity on a large scale. "Part 3: Special Issues" discusses global climate change, human influences (including a series of case studies of issues such as contaminants in fishes and molluscs, and racoon rabies as a consequence of translocation), non-native species, and habitat assessments. The publication focuses by necessity on specific areas. Nowhere, for instance, does it list all known fish species of the United States — that information is available elsewhere, as noted in the introduction. But issues of special significance such as rare, threatened and endangered fish species, Colorado river basin fishes and cutthroat trout in Glacier National Park, Montana are discussed. Every case study has commendable depth and there is great breadth of topics.

This report was written to document successful management efforts for future reference, to identify problems, to aid in cost-effective solutions and to highlight areas which need more research. It will also interest those (i.e. students, journalists and individuals) concerned with natural resource issues. This compilation will also serve to identify gaps in resource inventory and monitoring programs. Canadians reading this publication will see a similarity to both Environment Canada's "State of Canada's Environment" and Canadas country study of biodiversity, entitled *Canada's Biodiversity*.

There is an almost bewildering amount of information here, but the impression is one of a series of snapshots — there is never a big picture presented. Unlike the State of the Environment Report, no interpretation is provided. In every section, for instance, there are references to factors such as habitat alteration, resource extraction, and urbanization, but these issues are not discussed at a national level. I was somewhat relieved to read in the introduction that a second report, to have been published in 1995, was to have given a synthesis of the status and trends of the nation's biodiversity. This report presumably would have provided the overview and integration that was obviously missing in this volume. Nonetheless, with its wide variety of issues and case studies, this publication is a valuable addition and reference for those interested in specifics of US biodiversity.

Noel Alfonso, Canadian Centre for Biodiversity, Canadian Museum of Nature

A promising new framework to control desertification

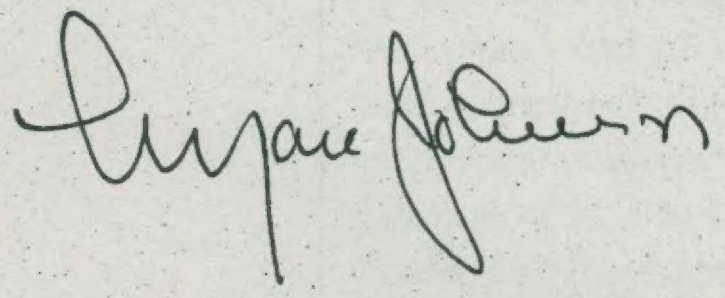
A new global framework for the control of desertification — one of the commitments made at the Earth Summit in Rio — is now a reality. *The United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, especially in Africa* was signed by 115 countries and came into force in December 1996 after the 60th country ratified the Convention.

The objective of this new international legal instrument is to protect the arid, semi-arid, and sub-humid lands of the Earth. It is estimated that 70% of these lands, which represent one quarter of the planet's land area above sea level, could become infertile. Almost 900 million people depend on these lands for survival. Moreover, these arid zones are home to an immense number of animal and plant species, now threatened by the disappearance of their habitat. Even though desertification is a global phenomenon, it is most prevalent in Africa.

Although influenced by climatic change, desertification is mainly caused by humans. Poverty, population growth, and unsuitable cropping practices lie at the root of many factors contributing to desertification, such as deforestation, overgrazing, overcultivation, and inadequate irrigation. In turn, desertification can cause food shortages, conflicts, and population migration, which can make it a security concern as well as an environmental and social concern.

In today's reality of shrinking financial resources, the Convention supports the development of a framework to better focus existing international financial resources and cultivate new ones, especially within the private sector. The Convention also encourages local communities and NGOs to develop original and sustainable solutions to the regional problems of desertification. Local development thus represents an important part of the Convention's approach, as well as the involvement of community groups.

The Convention on Desertification provides a new framework based on the coordination and efficient use of resources and on participation at the local level. If the countries that already contribute to agricultural programs are willing to participate within this framework, their participation will be a huge step forward to protecting the arid and semi-arid lands of the world. The Conference of Parties, which will take place in Rome in September 1997, will give the Parties the occasion to firmly plant this new sustainable development instrument.



Pierre Marc Johnson
IUCN Councillor for North America

A few words about the Canadian Museum of Nature

The origins of the Canadian Museum of Nature (CMN) were formed within the Geological Survey of Canada in 1842. Over 150 years later, the CMN has some 10 million specimens in its collection, which still represents only half the known species in this country, and an active team of scientists, collection managers, education specialists, and business experts.

The CMN's mandate is to increase knowledge and understanding of, appreciation and respect for, and interest in the natural world. This role has never been more crucial, as the demand for environmental harmony between the world's burgeoning human population and nature reaches a critical point. For more information about the Museum's activities, please contact Joanne Charette, Corporate Communications at (613) 566-4249.

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Published by:
Canadian Museum of Nature, P.O. Box 3443, Station D, Ottawa, Ontario K1P 6P4, Canada
ISSN 1195-3101 (English Edition) ISSN 1195-311X (édition française)

Introductions, like extinctions, are forever.

J. Ellen Marsden

For more on the introduction of alien species and their effects on nature biodiversity, see page 25.

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